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* Stewart, Hon. Alexander.
* Strong, Ven. Charles, A. M. Archdeacon of Glendalough. 6, *Cavendish-row.*
* Sweetman, Walter, Esq. 4, *Mountjoy-square, North.*

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Sausse, M. R., Esq. 5, *Hume-street.*
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Smith, Robert William, Esq., M. D. 63, *Eccles-street.*
Smith, Aquilla, M. D. 12, *Lower Baggot-street.*
Sproule, Oliver, Esq. 42, *Blessington-street.*
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Starkey, Digby Pilot, Esq. *Sandycove Terrace, Kingstown*, and *Accountant-General's Office, Four Courts.*
Stokes, William, M. D. Regius Professor of Medicine, University of Dublin. 5, *Merrion-square, North.*

* Tarrant, Charles, Esq., C. E. *Kilkenny.*
* Tennison, Edward King, Esq., M. P. *Kilronan, Keadue, Carrick-on-Shannon.*
* Thompson, James, Esq. *Glasgow.*

- Tibbs, Rev. Henry. *Nottingham.*
- Todd, Rev. James Henthorn, D.D., Fellow of Trinity College.—SECRETARY. 35, *College.*
- Turner, William, Esq.

Talbot, James, Esq. *Evercreech House, Shepton-Mallet, Somersetshire.*

Talbot, Matthew E., Esq. *Talbot Hall, Co. Waterford.*

Taylor, Very Rev. J. J., D.D., President of Carlow College. *Carlow.*

Taylor, Alexander, M.D. *Pau.*

Tighe, Robert, Esq. 14, *Fitzwilliam-square, North.*

Toleken, John, M.D., Fellow of Trinity College. *College.*

Townsend, William R., C.E. *Derry, Roscarberry.*

Tufnell, Thomas Jolliffe, M.D. 58, *Lower Mount-st.*

Tyrrell, John, Esq. *Totness,* and 6, *Merrion-square, West.*

- Vandeleur, Crofton Moore, Col. *Kilrush, Co. of Clare.*

Vignoles, Charles, Esq., F.R.S. *Trafalgar-square, London.*

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- Wall, Rev. Richard H., D.D. 6, *Hume-street.*
- Walshe, Francis Weldon, Esq. *Upper Glentworth-street, Limerick.*
- Weaver, Thomas, Esq., F.R.S. F.G.S. *London.*
- Weld, Isaac, Esq., F.G.S. Sec. Royal Dublin Society. *Ravenswell, Bray.*
- Wilkinson, James Tandy, Esq., M.D. *Limerick.*
- Williams, Thomas, Esq. *Drumcondra Castle,* and 38, *Dame-street.*
- Williams, Richard Palmer, Esq. *Drumcondra Castle,* and 38, *Dame-street.*
- Wilson, Rev. James, D.D. 10, *Harrington-street.*
- Wilson, Thomas, Esq. *Westbury,* and 15, *Upper Temple-street.*

* Wilson, Robert, Esq. 31, *Leeson-street.*
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Wallace, William Baillie, Esq., A. M. 3, *Palace-street.*
Waller, John Francis, Esq. 4, *Herbert-street.*
Wallscourt, Joseph Henry, Lord. *Ardfry, County of Galway.*
Webber, Charles T., Esq. 22, *Upper Gloucester-street.*
West, Rev. John, D.D. 28, *Herbert-place.*
Wilde, William R., Esq. 15, *Westland-row.*
Wilkinson, George, Esq. *Custom-House.*
Williams, Charles Wye, Esq. *Liverpool.*
Williams, Robert C., M. D. 58, *Upper Mount-street.*
Wills, Rev. James. *Suirville, Waterford.*
Wilme, Benjamin P., Esq., C. E. *Featherstone Buildings, Bedford-row, London.*
Wilson, Henry, M. D. *East India Company's Service, Bombay.*
Wingfield, Hon. and Rev. William. *Abbeyleix.*
Wynne, John, Esq. *Hazlewood, Co. Sligo.*

Yeates, George, Esq. 2, *Grafton-street.*

PROCEEDINGS

OF

THE ROYAL IRISH ACADEMY.

NOVEMBER 8TH, 1847.

REV. HUMPHREY LLOYD, D. D., PRESIDENT, in the Chair.

THE following Address, which was presented to the Lord Lieutenant on the 7th July last, together with His Excellency's Answer, was ordered to be entered on the Minutes:

"*To His Excellency the Right Honourable William Frederick Earl of Clarendon, Lord Lieutenant General and General Governor of Ireland, &c.*

"MAY IT PLEASE YOUR EXCELLENCY,

"We, the President and Members of the Royal Irish Academy, humbly beg your Excellency's permission to offer you our respectful congratulations on your arrival in this country, in the high character of Representative of our most gracious Sovereign.

"The Royal Irish Academy was incorporated at the close of the last century, for the Promotion of the study of Science, Polite Literature, and Antiquities, in Ireland.

"By the Charter of our Royal Founder, King George the Third, the office of Visitor of the Academy belongs to your Excellency, as Lord Lieutenant of Ireland.

"It becomes our duty, therefore, to solicit your Excellency's attention to the objects of the Academy, and to the manner in which we have endeavoured to carry those objects into effect. When your Excellency has leisure to inquire more minutely into our proceedings, we indulge a hope that you will recognise in the Royal Irish Academy a most important instrument of good for Ireland. The Academy, during a period of more than sixty years, has been the means of bringing into notice much of the talent of this country, which would otherwise, perhaps, have perished in obscurity; and the papers that have appeared in our Transactions have earned for us a reputation, not altogether insignificant, among the learned Societies and Academies of Europe.

"To the inheritor of the illustrious title of Clarendon, it is unnecessary to enlarge upon the advantages of an Institution which has for its objects the advancement of Literature and Learning. An indirect, but not unimportant benefit, resulting from such an Institution, is its tendency to diminish party strife and prejudice. The Academy has always been composed of men who differed from each other widely on many subjects; but their differences, hallowed by the calm pursuits of Science, have never interfered with that mutual forbearance and good will which is so essential to the right cultivation of Literature, and so eminently desirable in a country like this.

"That such benevolent and kindly feelings, with learning and all useful knowledge, may be effectually promoted in every part of Ireland under your Excellency's government, is our earnest hope and prayer."

ANSWER.

"Mr. President and Gentlemen of the
Royal Irish Academy,

"I beg you will accept my sincere acknowledgments for the kind and flattering terms in which you have conveyed to me your congratulations upon my arrival in this country.

"I anticipate the highest gratification from the performance of my duty as Visitor of the Royal Irish Academy, because I feel convinced that personal observation and inquiry can only confirm the opinion that I entertain, that you have well understood, and have effectually carried out, the noble objects of your Institution, by promoting the study of Science, by fostering the talent of Ireland, and by publishing those results of your labours, which have earned for the Academy, both at home and abroad, the reputation it so justly enjoys.

"No higher tribute can be paid to Science and Literature, —no proof more convincing of their general influence can be found,—than the fact that, during a period of sixty years, throughout which dissensions have unhappily, and almost without interruption, prevailed in this country, the Royal Academy has always kept aloof from the strife of parties, and has presented a neutral ground, where men of opinions the most opposite could meet for a common purpose, where the voice of passion was not heard, and where each was intent upon the good of all.

"The Members of the Academy must feel an honest pride in having thus afforded an example of that mutual forbearance and good will which are of vital importance to the progress and prosperity of Ireland. The necessity and the advantages of such benevolent feelings are now, I rejoice to think, generally recognised, and I shall consider myself most fortunate, if my unceasing efforts to promote them, together with the diffusion of knowledge, are attended with the success I desire; for I am well assured that nothing, at the present moment, would be more useful to Ireland, or more faithfully fulfil the gracious intentions of our Sovereign."

It was resolved,—That we have received with the deepest sorrow the intelligence of the calamitous event which has deprived the Academy, the University, and the scientific world, of so bright an ornament as Professor Mac Cullagh.

That we beg leave to offer our sincere condolence and sympathy to his family, under an affliction so deplorable and irreparable.

That we shall ever cherish, with sentiments of the most poignant regret, the memory of one, to whose zeal and munificence this Academy especially is so deeply indebted.

That, as an expression (however feeble and inadequate) of our sorrow for his memory, the Academy do now adjourn, without proceeding to transact any of the ordinary business of this Meeting.

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November 30th, 1847.—(Stated Meeting.)

REV. HUMPHREY LLOYD, D. D., President,
in the Chair.

The Rev. Samuel Haughton was elected a Member of the Committee of Science; and Eaton Hodgkinson, Esq., F. R. S., was elected a Member of the Academy.

The Council having recommended the Academy to sanction an exchange of antiquities proposed by Mr. Staunton, of Longbridge, near Warwick,

It was Resolved,—That the brass seal in the Museum of the Academy, with the legend, "Sigillum peculiaris Jurisdictionis de F Fysshers Itchyngton," be given to Mr. Staunton in exchange for a seal made of slate, having the legend "Sigillum dñi iohīs ep̄i limirensis."

Read,—The following translation of a letter from the Royal Commission for the Preservation of Antiquities, dated Copenhagen, June 26, 1847:

"Mr. J. J. A. Worsaae, well known by his writings and antiquarian researches, both in his own country and in the foreign countries in which he has travelled, has delivered from the Royal Irish Academy to the Museum of Northern Antiquities of this place, a small series of specimens of Irish Antiquity, which both serve to illustrate those of the North, and are also interesting for the purpose of comparison.

" Of still greater importance to antiquarian science, and therefore doubly welcome and useful to us, is the valuable gift (likewise brought over by our above-mentioned countryman) of twelve large sheets of drawings of the most important objects of antiquity to be found in the collection of the Irish Academy.

" Although the articles fabricated in most countries have gradually come to acquire some peculiar impress, there is, nevertheless, a certain agreement in the primitive specimens of different regions, which it is instructive to know; and, as regards England and Ireland, these countries possess the additional interest to the Northman, that he may there expect to find what has originated from his forefathers.

" Our Museums, as Mr. Worsaae has already suggested, will best illustrate what may reasonably be supposed to have belonged to our forefathers. It will afford us pleasure to contribute by our exertions to the further elucidation of this subject.

" In expressing our deep sense of the kind attention shewn to us, we shall endeavour, at a future period, to return our thanks by transmitting to the Academy such matters as we may deem of value for its collections, and shall be glad henceforward to give and receive information, such as may be of use for the history of the North and of Ireland.

" (Signed) FREDERIK, *Crown Prince.*
WERLAUFF.
FINN MAGNUSEN.
C. J. THOMSEN.
C. C. RAFN.

" *To the Royal Irish Academy.*"

Mr. E. J. Cooper read the following paper on the Determination of Differences of Longitude by means of Shooting Stars.

" It is not my intention, upon the present occasion, to make any remarks on the various theories that have been published on the subject of what are commonly called shooting stars; I desire merely to lay before the Academy the result of a rough experiment which I recently instituted, to obtain by them differences of longitude between two stations.

" Artificial signals have been frequently adopted for this purpose, and by none with more perfect success than by my excellent friend, Dr. Robinson, of Armagh. The Academy knows that, to conclude the difference of longitude between Dunsink and Armagh, he obtained rockets from the Ordnance, which were fired on Slieve Gullion, and the instant of their extinction was noted at the two Observatories. The result was within $0^{s}\cdot03$ of that given by the mean of fifteen chronometers belonging to Mr. Dent, the celebrated maker in London. In the year 1841 the difference of longitude was sought in a similar way, between the Observatories of Armagh and Markree. The rockets were fired on Culkagh, but, unfortunately, only seven were observed at both places. The result, however, only differed 1^{s} from that deduced, by the kindness of Captain Larcom, from the Ordnance Survey.

" It can scarcely be necessary to remind the Academy that these artificial projectiles are not always available for the purpose, inasmuch as the height to which they can be made to rise is limited, and there is also a difficulty in securing their sudden extinction. Differences of longitude between places far separated from one another on the earth's surface, cannot, therefore, be decided by their means.

" I believe that the idea of making shooting stars subservient to this end is by no means new; but I am not aware of its having been carried into practice. They have been observed at two stations to ascertain their *distance* from the earth through parallax; but I fancy that there has no experiment been made similar to that which I am about to submit to your notice.

"Previous to the periodical display of these singular phenomena in August last, I communicated with Mr. Graham, my first assistant at the Markree Observatory, suggesting that we should make the trial of obtaining the difference of longitude between Markree Observatory and the Obelisk at Killiney, by means of shooting stars. I fixed on the evenings of the 10th, 11th, and 12th of August, as those on which it was most probable that the greatest number of these phenomena would be seen; and the room and gallery of the Obelisk were most obligingly placed at my disposal by Mr. Warren.

"The Markree mean times were, of course, easily determined. Those at Killiney were deduced from transits, observed with a beautiful little universal instrument by MM. Ertels, of Munich, and a sidereal chronometer by the late Mr. Sharp, of this city. On the 10th and 12th of August, the shooting stars were noted at both stations: on the 11th only at Markree, the night being overcast with rain at Killiney. I have the honour to present the lists of those seen at Markree and Killiney on the 10th and 12th.

"The first column of the Markree lists gives the number; the second, the mean time at station; the third and fourth, the apparent place in the heavens, wherein the phenomena firstly and lastly were observed; the fifth, their estimated duration; the sixth, their magnitude compared with the fixed stars; and the last, general remarks thereon.

"The first column of the Killiney lists gives the number; and the second, the mean time at station; but the third, containing the supposed mean time at Markree, corresponding to the mean time at Killiney, by estimation of the difference of longitude, was introduced by me for the purpose of facilitating the identification of the objects seen at both the stations. This was necessarily a rough approximation, obtained as follows:

"The longitude of Dunsink, according to the Nautical Almanac, $= 25^{m}\ 22^{s}$ W. of Greenwich; and that of Markree Observatory, $= 33^{m}\ 48^{s}{\cdot}4$ W. Thus the difference of longitude between Dunsink and Markree $= 8^{m}\ 26^{s}{\cdot}4$. Applying a scale to the Ordnance Sketch Map of the county of Dublin, the Obelisk at Killiney appeared to be nearly 9·55 statute miles to the eastward of Dunsink; and then, assuming a degree of longitude in latitude 53° 15′ to equal about 41·45 statute miles, a simple rule of three gave the difference of longitude in time between Dunsink and Killiney $= 55^{s}{\cdot}3$. This being added to $8^{m}\ 26^{s}{\cdot}4$, the difference between Dunsink and Markree, produced the result,—difference of longitude between Markree Observatory and the Obelisk at Killiney $= 9^{m}\ 21^{s}{\cdot}7$. With this result I estimated the times at Markree corresponding to the times at Killiney.

"Upon my sending my observations on the 10th and 12th to Mr. Graham, he identified my Nos. 30 and 38 with his Nos. 13 and 71 on the night of the 10th. These two shooting stars gave difference of longitude respectively $= 9^{m}\ 20^{s}{\cdot}9$ and $9^{m}\ 19^{s}{\cdot}9$; the mean, $9^{m}\ 20^{s}{\cdot}4$, differing from the longitude assumed by me in the amount $1^{s}{\cdot}3$. But I subsequently discovered that the shooting stars, No. 8 Markree, and No. 27 Killiney, on the night of the 12th, were one and the same, giving, for difference of longitude, $9^{m}\ 23^{s}{\cdot}4$. The mean of the three is $9^{m}\ 21^{s}{\cdot}4$, which differs only $0^{s}{\cdot}3$ from that which I had estimated.

"That the result is in reality as satisfactory as it appears to be, I cannot assert. Fractions of seconds in the observations could scarcely have been attended to under the circumstances, and therefore were neglected; those appearing in the lists, arising from the application of the corrections for clock at

Markree, and sidereal chronometer at Killiney. I also neglected the difference of longitude between the Obelisk and transit instrument. Thus, a very accurate result could scarcely be expected from but three comparisons.

"With reference to the two phenomena of August 10th, I have to remark, that if the lines of apparent direction of No. 38 Killiney, and No. 71 Markree, be produced to the horizon, the azimuthal difference would amount to 120°; and in the case of No. 30 Killiney, and No. 13 Markree, the difference would be still greater. This observation does not apply to No. 27 Killiney, and No. 8 Markree, on the night of the 12th. Here the parallax was small, and it seems almost certain that the commencement of visible trajectory was observed at Markree, and the end at Killiney. The two shooting stars of the 10th must have been much nearer to the earth than that of the 12th. Supposing the parallax to be 120°, the distance of the object from each station would be to the distance of the stations from one another as 1 to $\sqrt{3}$. The base in the experiment before us = 98 miles. It is somewhat singular that No. 29 Killiney, and No. 10 Markree, on the night of the 12th, and described at both stations to be of extreme brilliancy, and with magnificent train, should have been seen within 10' of each other in the same apparent line on the map, but moving in opposite directions."

Shooting Stars observed at Killiney, August 10, 1847.

No.	M.T.Killiney.	Calculated M.T.Markree.	From.	To.	Dur.	Mag.	Remarks.
	h. m. s.	h. m. s.					
1	9 27 0.5	9 17 38.8	α Urs. Min.	α Urs. Maj.	0.5	2	No train.
2	9 30 0.0	9 20 38.3	γ Andromed.	α Arietis.			
3	9 34 59.2	9 25 37.5	Do.	β Andromed.	. .	2	Train.
4	9 38 58.5	9 29 36.8	*y* Piscium.	α Pegasi.			
5	9 43 34.8	9 34 13.1	α Cephei.	α Urs. Min.	. .	1	Train.
6	9 44 14.7	9 34 53.0	Do.	Do.	. .	1	Train.
7	9 44 19.7	9 34 58.0	κ Draconis.	δ Urs. Maj.	. .	1	Train.
8	9 47 24.2	9 38 2.5	α Urs. Min.	η Urs. Maj.	0.5	4	No train.
9	9 48 48.9	9 39 27.2	β Trianguli.	α Piscium.	. .	. .	Train.
10	9 49 18.8	9 39 57.1	A little north of preceding,	. . . . . .	1.0	3	No train.
11	9 56 12.7	9 46 51.0	α Cassiop.	Over β Androm.	1.0	2	No train.
12	9 57 47.5	9 48 25.8	δ Androm.	σ Androm.			
13	9 58 47.3	9 49 25.6	α Aurigæ.	π Aurigæ.			
14	9 59 57.1	9 50 35.4	α Urs. Min.	δ Camelop.			
15	10 0 37.0	9 51 15.3	δ Camelop.	α Urs. Maj.	. .	1	Train.
16	10 5 1.3	9 55 39.6	λ Draconis.	ε Urs. Maj.	1.0	3	Slight train.
17	10 6 13.1	9 56 51.4	α Urs. Maj.	Parallel to tail of Draco.	0.5	5	No train.
18	10 7 45.8	9 58 24.1	γ Urs. Maj.	α Draconis.	1.0	1	No train.
19	10 8 30.7	9 59 19.0	α Draconis.	Thro' α Urs. Maj.	10.0	1	Train very long.
20	10 11 15.2	10 1 53.5	γ Androm.	β Androm.	0.7	3	No train.
21	10 12 59.9	10 3 38.2	β Androm.	γ Piscium.	. .	4	
22	10 13 59.8	10 4 38.1	Do.	Do.			
23	10 14 19.7	10 4 58.0	β Piscium	Saturn.			
24	10 16 16.4	10 6 54.7	α Urs. Min.	Vertically down.			
25	10 18 36.0	10 9 14.3	Delphinus.	Do.			
26	10 19 13.9	10 9 51.2	η Urs. Maj.	α Can. Ven.			
27	10 19 33.9	10 10 11.2	43 Camelop.	χ Draconis.	. .	. .	Train very good.
28	10 24 53.0	10 15 31.3	Neb. Androm.	δ Androm.	0.5	3	No train.
29	10 26 2.8	10 16 41.1	*e* Lacertæ.	α Lyræ.	0.5	3	No train.
30	10 28 32.4	10 19 10.7	Half way between Pole & α Urs. Maj.	α Urs. Maj.	1.0	4	No train.
31	10 33 11.6	10 23 49.9	β Trianguli.	δ Trianguli.	0.3	4	No train.
32	12 4 20.7	11 54 59.0	α Arietis.	Mars.	0.5	4	No train.
33	12 5 45.4	11 56 23.7	β Trianguli.	η Piscium.	0.5	3	No train.
34	12 15 43.8	12 6 22.1	α Urs. Min.	β Urs. Min.			
35	12 19 33.2	12 10 11.5	Do.	β Bootis.			
36	12 20 43.0	12 11 21.3	γ Androm.	α Urs. Maj.	0.5	3	No train.
37	12 22 42.6	12 13 20.9	δ Cassiop.	β Ceti.	1.0	1	No train.
38	12 26 12.1	12 16 50.4	ε Urs. Maj.	α Can. Ven.			
39	12 27 31.9	12 18 10.2	α Persei.	α Aurigæ.			
40	12 27 51.8	12 18 30.1	α Urs. Min.	λ Draconis.			
41	12 30 1.4	12 20 39.7	α Arietis.	Mars.			
42	12 30 41.3	12 21 19.6	γ Androm.	Thro' Pleiades.			
43	12 31 11.3	12 21 49.6	Pleiades.	Mars.			
44	12 31 51.1	12 22 29.4	Parallel to & N. of α Aurigæ & β Aurigæ.	. . . . . .	1.0	1	No train.
45	12 34 5.8	12 24 44.1	A Urs. Maj.	λ Urs. Maj.	. .	. .	No train.
46	12 42 34.4	12 33 12.7	A Urs. Maj.	Below β Urs. Maj.	1.0	2	Slight train.

Shooting Stars observed at Markree, August 10, 1847.

Calculated M. T. Markree.	From.	To.	Dur.	Mag.	Remarks.
h. m. s.			s.		
9 10 9.0	α Urs. Min.	γ Orionis.	0.4	2	No train.
9 13 19.1	ι Draconis.	α Bootis.	0.5	5	No train.
9 15 25.1	α Cephei.	α Lyræ.	0.5	1	No train.
9 18 50.1	α Cygni.	Downwards.	0.5	1	No train.
9 20 7.1	β Urs. Maj.	η Bootis.	0.3	2	No train.
9 23 21.1	δ Cassiop.	α Persei.	0.5	4	
9 24 35.1	γ Cassiop.	α Cephei.	0.4	3	
9 27 20.1	ι Cassiop.	Thro' α Urs. Min.	1.0	1	No train.
9 35 58.2	ζ Cassiop.	Upward.	0.5	2	
10 13 10.5	γ Cor. Bor.	Southward.	0.5	1	No train.
10 14 5.5	α and β Cephei.	Horizontal.	0.2	5	
10 16 20.5	α Urs. Min.	Across β Urs. Maj.	0.5	2	
10 19 11.5	α Androm.	Downward.	0.4	3	
10 20 50.5	Across α Urs. Min. and γ Urs. Min.	. . . .	0.1	1	Fine train.
10 23 0.5	Pretty low in W. near α Bootis.	. . . .	0.3	2	No train.
10 24 6.5	Across β Cephei.	Horizontal.	0.3	4	
10 27 35.5	Across Ursa Major.	. . . .	2.5	. .	Train lasted 3 or 4 s. bright as Jupiter
10 28 25.6	Above Auriga.	. . . .	0.5	2	No train.
10 29 0.6	Do.	. . . .	0.7	1	No train.
10 33 3.6	Below φ Urs. Min.	γ Urs. Maj.	0.5	2	
10 34 5.6	Near α Bootis.	. . . .	0.3	3	
10 34 55.6	Caught a glimpse of it in W.	. . . .	0.7	2	
10 38 14.6	γ Urs. Maj.	α Can. Ven.	0.4	3	
10 40 14.6	Across α Lyræ.	. . . .	0.6	2	
10 41 11.6	ζ Urs. Min.	η Draconis.	0.4	2	
10 42 44.6	ι Draconis.	Horizontal.	0.4	3	No train.
10 46 7.6	ε Cassiop.	α Urs. Min.	0.2	2	Fine train.
10 51 2.7	Below α Urs. Min.	γ Urs. Maj.	0.3	4	No train.
10 51 3.7	Do.	Do.	0.5	1	
10 51 35.7	Do.	Do.	0.6	2	
10 52 5.7	Do.	Do.	0.4	3	
10 53 0.7	Very little above α Lyræ.	Southwards.	1.0	2	
10 53 30.7	Farther above do.	α Urs. Min.	0.2	2	
10 55 55.7	In Perseus.	. . . .	0.2	4	
10 56 59.7	η Urs. Min.	Southward.	0.3	5	
11 2 40.7	χ Draconis.	Downward.	0.4	3	
11 3 40.7	Along in North,	. . . .	0.2	3	
11 5 6.7	α Urs. Min.	α Lyræ.	0.3	4	
11 7 25.7	Across α Urs. Maj.	. . . .	0.2	3	No train.
11 8 20.7	α Urs. Min. across γ Urs. Maj.	. . . .	0.7	1	Train.
11 8 40.7	In head of Urs. Maj.	. . . .	0.4	2	No train.
11 10 53.8	Above α Urs. Min.	Horizontal.	0.2	5	
11 12 33.8	Do.	Do.	0.2	3	
11 12 47.8	Below α Urs. Min.	δ Urs. Maj.	0.2	4	

Shooting Stars observed at Markree, August 10, 1847.

No.	Calculated M. T. Markree.	From.	To.	Dur.	Mag.	**Remarks.**
	h. m. s.			s.		•
45	11 13 51.8	θ Bootis.	Southward.	0.3	3	**No train.**
46	11 15 0.8	Do.	Do.	0.5	1	**Train.**
47	11 15 25.8	Across Cassiopeiæ.	. . . .	0.5	3	**Train.**
48	11 16 54.8	α Urs. Maj. across γ Urs. Maj.	. . . .	0.5	2	**No train.**
49	11 17 52.8	θ Bootis.	γ Urs. Maj.	0.2	3	
50	11 18 25.8	Above α Urs. Min.	Horizontal.	0.3	3	
51	11 18 36.8	θ Urs. Maj.	γ Urs. Maj.	0.7	2	
52	11 19 26.8	Above α Urs. Min.	Horizontal.	0.2	5	
53	11 20 10.8	ε Cassiop.	α Urs. Min.	0.2	4	
54	11 21 53.8	Above θ Urs. Maj.	α Bootis.	0.2	2	
55	11 21 57.8	Between ε Urs. Maj. and α Bootis.	. . . .	0.2	2	
56	11 23 43.8	Across θ Bootis.	Southward.	0.2	3	
57	11 25 33.8	ε Draconis.	Southward.	1.0	4	**No train.**
58	11 43 42.0	Π Urs. Maj.	ψ Urs. Maj.	0.5	2	**No train. (I cann make out letter.**
59	11 43 55.0	Below β Urs. Maj.	χ Urs. Maj.	0.2	4	
60	11 44 41.0	Below α Urs. Min.	. . . .	0.2	4	**No train.**
61	11 47 8.0	Do.	. . . .	0.2	3	**Train.**
62	11 48 30.1	γ Cephei.	χ Cephei.	0.4	2	**Train.**
63	11 53 6.1	Above α Urs. Min.	Horizontal.	0.5	3	**No train.**
64	11 53 36.1	Above α Bootis.	β Cephei.	0.7	. .	**No train, brigh as Jupiter.**
65	11 55 46.1	In zenith. Caught a glimpse.	. . . .	0.2	2	**No train.**
66	11 59 11.1	γ Cassiop.	β Cassiop.	0.2	2	
67	11 59 52.1	Below α Urs. Min.	. . . .	0.4	1	**No train.**
68	12 0 26.1	α Aurigæ.	Downward.	0.4	2	
69	12 1 31.1	Above α Urs. Min.	Π Draconis.	0.4	3	**(Cannot make ou letter.)**
70	12 11 51.2	Thro' α Urs. Min.	Downward.	0.4	2	
71	12 16 52.2	α Urs. Min.	Auriga.	0.3	3	
72	12 18 50.2	Thro' χ Draconis.	ε Urs. Maj.	0.3	3	
73	12 23 0.2	ρ Urs. Maj.	β Urs. Maj.	0.5	1	**No train.**
74	12 24 36.2	η Urs. Maj.	Southward.	0.2	2	**Caught a glimpse**
75	12 32 1.3	A little North of α Aurigæ, parallel to the line joining α and β Aurigæ.	. . . .	0.3	2	**No train.**
76	12 35 27.3	β Cassiop.	α Cephei.	0.5	. .	**No train, brigh as Jupiter.**
77	13 2 31.4	Below α Urs. Min.	. . . .	0.5	1	**No train.**
78	13 6 29.4	Thro' Camelop.	Downward.	0.2	3	
79	13 8 32.4	ζ Urs. Maj.	ρ Urs. Maj.	0.2	3	
80	13 11 21.5	Thro' tail of Draco.	Downward.	1.0	4	
81	13 12 56.5	Thro' Camelop.	β Urs. Min.	1 0	4	**No train.**
83	13 18 37.5	γ Urs. Min.	Southward.	0.4	2	**No train.**

Shooting Stars observed at Killiney, August 12, 1847.

o.	M. T. Killiney.	Calculated M. T. Markree	From.	To.	Dur.	Mag.	Remarks.
	h. m. s.	h. m. s.					
1	9 35 37.0	9 26 15.3	35 Camelop.	β Lyræ.	1.0	3	Slight train.
2	9 38 36.5	9 29 14.8	Under α Urs. Min.	Camelop.	2.0	1	Long train.
3	9 41 59.9	9 32 38.2	β Cassiop.	β Cygni.	3.0	1	Magnificent train
4	9 43 45.6	9 34 23.9	α Ceti.	Thro' Mars.	0.5	3	No train.
5	9 50 59.5	9 41 37.8	In Ursa Minor.				
6	9 54 28.9	9 45 7.2	Thro' Aries.				
7	9 58 3.3	9 48 41.6	y Andromed.	α Andromed.	0.5	3	No train.
8	9 59 29.1	9 50 7.4	γ Andromed.	γ Cephei.	0.5	3	No train.
9	10 0 56.8	9 51 35.1	γ Andromed.	β Persei.			
0	10 5 27.1	9 55 5.4	α Persei.	Towards Urs. Maj.	1.0	2	No train.
1	10 15 15.5	10 5 53.8	η Urs. Maj.	α Bootis.	0.5	3	
2	10 15 15.5	10 5 53.8	Do.	Do.			
3	10 15 45.4	10 6 23.7	α Persei.	Triangul.	. .	1	Slight train.
4	10 20 44.6	10 11 22.9	β Persei.	Do.	1.0	2	Slight train.
5	10 28 33.3	10 19 11.6	δ Cassiop.	α Cygni.	1.0	1	No train.
6	10 35 7.2	10 25 45.5	Cassiop.	α Urs. Maj.	0.5	4	No train.
7	10 38 10.7	10 28 48.0	Triangul.	α Andromed.	2.0	1	Very fine train.
8	10 40 50.3	10 31 28.6	Musca.	α Arietis.	1.0	2	Slight train.
9	10 41 20.2	10 31 58.5	α Urs. Min.	ε Urs. Maj.			
20	10 42 5.1	10 32 43.4	Do.	ρ Urs. Maj.			
21	10 48 49 0	10 39 27.3	Do.	Thro' Urs. Min.			
22	10 50 48.6	10 41 26.9	α Andromed	α Urs. Min.			
23	10 52 28.4	10 43 6.7	ε Cassiop.	Cerv. Island.	1.0	3	Slight train.
24	11 35 56.2	11 26 34.5	α Persei.	α Aurigæ.	0.5	2	No train.
25	11 36 16.2	11 26 54.5	α Androm.	Saturn.			
26	11 38 0.9	11 28 39.2	β Urs. Maj.	α Can. Ven.	1.0	2	Slight train.
27	11 41 20.3	11 31 58.6	α Urs. Maj.	χ Urs. Maj.			
28	11 42 0.2	11 32 38.5	Thro' the three principal stars of Perseus.				
29	11 44 59.7	11 35 38.0	β Urs. Min.	γ Bootis.	10.0	1	Magnificent train
30	11 51 18.7	11 41 57.0	κ Cygni.	α Cygni.			
31	11 53 43.3	11 44 21.6	γ Androm.	Mars.			
32	11 55 57.9	11 46 36.2	ε Cassiop.	α Cephei.	1.0	2	Slight train.
33	11 57 27.7	11 48 6.0	Pleiades.	S. Horizon.	1.0	2	Slight train.
34	12 6 21.2	11 56 59.5	β Urs. Min.	α Cor. Bor.	0.5	3	No train.
35	12 7 46.0	11 58 24.3	λ Urs. Maj.	ε Urs. Maj.	0.5	4	No train.
36	12 15 49.7	12 6 28.0	ε Urs. Maj.	α Bootis.	1.0	3	No train.
37	12 23 52.3	12 14 30.6	Downwards thro' Perseus.				
38	12 24 26.3	12 15 4.6	Mars.	Vertically down.	1.0	2	No train.
39	12 25 35.1	12 16 13.4	β Urs. Min.	Hercules.	0.5	3	No train.
40	12 28 34.6	12 19 12.9	ε Cassiop.	γ Cephei.	1.0	2	Fine train.

Shooting Stars observed at Markree, August 12, 1847.

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No.	Calculated M. T. Markree.	From.	To.	Dur.	Mag	Remarks.
	h. m. s.					
1	11 5 21.6	21 Can. Ven.	α Bootis.	0.5	2	No train.
2	11 8 57.7	α Draconis.	γ Bootis.	0.3	3	
3	11 10 41.8	α Cassiop.	ρ Cygni.	0.2	5	
4	11 17 17.8	ζ Urs. Maj.	Upward.	0.6	5	No train, rather slow.
5	11 18 21.8	In Camelop.	Downward.	0.2	3	Train.
6	11 27 47.8	Vulpecul.	Pole.	0.4	3	No train.
7	11 30 20.9	ε Urs. Min.	χ Cephei.	1.0	1	No train. Slow.
8	11 31 56.9	Across D Camelop	Head of Urs. Maj.	0.2	4	
9	11 34 38.9	Vertex of Δ in Camelop.	λ Urs. Maj.	0.4	4	
10	11 35 28.9	ε Cassiop.	α Andromed.	1.5	. .	Train lasted 20 s. as bright as Jupiter
11	11 46 18.9	Between α Cephei and α Cygni.	α Lyræ.	0.3	6	No train.
12	11 51 30.0	γ Urs. Min.	γ Bootis.	0.6	5	
13	11 53 1.0	η Draconis.	Thro' Cor. Bor.	0.3	5	
14	12 25 56.1	α Urs. Min.	ζ Urs. Maj.	0.6	1	Seen thro' a cloud.
15	12 26 24.1	θ Bootis.	γ Bootis.	0.2	3	No train.
16	12 27 19.9	In head of Urs. Maj.	. . . . .	0.7	1	Train seen in a cloud.
17	14 28 9.0	Thro' α and δ Urs. Min.	. . . . .	0.3	3	No train.
18	14 33 13.0	γ Cephei.	Thro' φ Draconis.	0.4	2	Train.
19	14 38 57.0	Below α Urs. Min.	η Urs. Min.	0.2	3	No train.
20	14 43 46.0	η Persei.	ζ Aurigæ.	0.4	2	
21	14 52 54.1	Head of Urs. Maj.	Vertically down.	0.2	3	
22	14 54 0.1	Near α Lyræ.	Downwards.	0.4	2	
23	14 56 0.1	γ Cephei.	Eastward.	1.5	2	
24	14 56 30.1	Above γ Cephei.	Westward.	0.2	2	
25	15 0 5.1	β Andromed.	Southward.	0.7	1	No train.

The Rev. Dr. Robinson made some remarks on Mr. Cooper's communication, and called the attention of the meeting to observations made by Mr. Cooper on shooting stars seen by him in the daytime.

Sir W. Rowan Hamilton gave an account of some additional applications of Quaternions to Surfaces of the Second Order.

In the Abstract printed as part of the Proceedings of the

Academy for July 20, 1846, the following equation of the ellipsoid (there numbered 44),

$$\mathrm{T}(\iota\rho + \rho\kappa) = \kappa^2 - \iota^2, \tag{1}$$

was given, as a transformation of this other equation of the same surface (there marked 35):

$$\mathrm{T}(\alpha\rho + \rho\alpha + \beta\rho - \rho\beta) = 1; \tag{2}$$

which was itself deduced by transforming, according to the rules of quaternions, the formula

$$(\alpha\rho + \rho\alpha)^2 - (\beta\rho - \rho\beta)^2 = 1; \tag{3}$$

this last quaternion form of the equation of the ellipsoid having been previously exhibited to the Academy, at its meeting of December 8, 1845. (See the equation numbered 21, in the Proceedings of that date.) The symbols α, β, denote two constant vectors; the symbols ι, κ, denote two other constant vectors, connected with them by the relations

$$\alpha + \beta = \frac{\iota}{\iota^2 - \kappa^2}, \quad \alpha - \beta = \frac{\kappa}{\iota^2 - \kappa^2}, \tag{4}$$

where $\iota^2 - \kappa^2$ is a negative scalar; and ρ denotes a variable vector, drawn from the centre to the surface of the ellipsoid: while T is the characteristic of the operation of taking the *tensor* of a quaternion.

If a new variable vector ν be defined, as a function of the three vectors ι, κ, ρ, by the equation

$$(\kappa^2 - \iota^2)^2\, \nu = (\kappa^2 + \iota^2)\, \rho + \iota\rho\kappa + \kappa\rho\iota, \tag{5}$$

it results from the general rules of this calculus that this new vector ν will satisfy each of the two following equations:

$$\mathrm{S}\,.\,\nu\rho = 1; \quad \mathrm{S}\,.\,\nu \mathrm{d}\rho = 0; \tag{6}$$

which give also these two other equations, of the same kind with them, and differing only by the interchange of the two symbols ρ and ν:

$$\mathrm{S}\,.\,\rho\nu = 1; \quad \mathrm{S}\,.\,\rho \mathrm{d}\nu = 0; \tag{7}$$

where d is the characteristic of differentiation, and S is that of the operation of taking the scalar part of a quaternion. The equations (6) shew that ν is the vector, of which the reciprocal ν^{-1} represents in length and in direction the perpendicular let fall from the common origin of the variable vectors here considered on the plane which touches at the extremity of the vector ρ the locus of that variable extremity; so that ν^{-1} is here a symbol for the perpendicular let fall from the centre of the ellipsoid on the tangent plane to that surface: and ν itself denotes, in length and in direction, the reciprocal of that perpendicular, so that it may be called the *vector of proximity* of the tangent plane, or of the element of the surface of the ellipsoid, to the centre regarded as an origin. Accordingly, the equation here marked (5) was given in the Abstract of July, 1846 (where it was numbered 45), as a formula for determining what was there also called the vector of proximity of the tangent plane of the ellipsoid. It may now be seen that the symbolical connexion between the two equations above marked (6), and the two other equations lately numbered (7), corresponds to, and expresses, in this Calculus, under what may be regarded as a strikingly simple form, the known connexion of *reciprocity* between any two surfaces, of which one is the locus of the extremities of straight lines drawn from any fixed point, so as to be in their directions perpendicular to the tangent planes of the other surface, and in their lengths inversely proportional to those perpendiculars: from the perception of which *general* relation of reciprocity between surfaces, exemplified previously for the case of two reciprocal ellipsoids by that great geometrical genius (Professor Mac Cullagh), whose recent and untimely loss we all so deeply deplore, the author of the present communication was led to announce to the Academy, in October, 1832, the existence of certain *circles of contact* on Fresnel's wave, which he saw to be a necessary consequence of the existence of certain *conical cusps* on another and reciprocal surface. A very elegant *geometrical* proof of the same general theorem of reciprocity was given afterwards, in the Transactions* of this Academy, by Professor Mac Cullagh himself.

As respects the reciprocal ellipsoid, of which the vector ν, in the equation lately marked (5), denotes a semidiameter, it may be mentioned here that, with the same significations of the symbols, the following equation holds good:

$$(2\beta \mathrm{S} \, . \, \alpha\beta)^2 = (\beta \mathrm{S} \, . \, \beta\nu)^2 + (\mathrm{V} \, . \, \beta \mathrm{V} \, . \, \alpha\nu)^2; \qquad (8)$$

with equations for other central surfaces of the second order, regarded as reciprocals of central surfaces, which differ only in the signs of their terms from this equation (8). The author proposes, in a future continuation of the present communication, to illustrate this new form, as regards the processes of obtaining and of interpreting it. Meanwhile he desires to submit to the notice of the Academy the following construction, for generating a system of two reciprocal ellipsoids, by means of a moving sphere, to which his own methods have conducted him, although it may turn out to have been already otherwise discovered. Let then a sphere of constant magnitude, with centre E, move so that it always intersects two fixed and mutually intersecting straight lines, AB, AB', in four points, L, M, L', M', of which L and M are on AB, while L' and M' are on AB'; and let one diagonal LM', of the inscribed quadrilateral $LMM'L'$, be constantly parallel to a third fixed line AC, which will oblige the other diagonal ML' of the same quadrilateral to move parallel to a fourth fixed line AC'. Let N be the point in which the diagonals intersect, and draw AF equal and parallel to EN; so that $AENF$ is a parallelogram: then *the locus of the centre E of the moving sphere is one ellipsoid, and the locus of the opposite corner F*

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* See the beautiful paper entitled, "Geometrical Propositions applied to the Wave Theory of Light. By James Mac Cullagh, F. T. C. D." Read June 24, 1833. Transactions of the Royal Irish Academy, vol. xvii.

of the parallelogram is another ellipsoid reciprocal thereto. These two ellipsoids have a common centre, namely, the point A; and a common mean axis, which is equal to the diameter of the moving sphere. Two sides, AE, AF, of the parallelogram $AENF$, are thus two semidiameters, which may be regarded as reciprocal to each other, one of the one ellipsoid, and the other of the other. It is, however, to be observed, that they fall at opposite sides of the principal plane, containing the four fixed lines, and that, therefore, it may be proper to call them more fully *opposite reciprocal semidiameters;* and to call the points E and F, in which they terminate, *opposite reciprocal points.* The two other sides, EN, FN, of the same varying parallelogram, are the normals to the two ellipsoids, meeting each other in the point N, upon the same principal plane. In that plane, the two former fixed lines, AB, AB', are the axes of the two cylinders of revolution which are circumscribed about the first ellipsoid; and the two latter fixed lines, AC, AC', are the two cyclic normals of the same first ellipsoid: while the diagonals LM', ML', of the inscribed quadrilateral in the construction, are the axes of the two circles on the surface of that ellipsoid, which circles pass through the point E, that is through the centre of the moving sphere, and which are also contained upon the surface of another sphere, having its centre at the point N: all which is easily adapted, by suitable interchanges, to the other or reciprocal ellipsoid, and flows with great facility from the quaternion equations above given.

It may not be out of place to mention, on this occasion, although for the present without its demonstration, another simple geometrical construction connected with a surface of the second order, and derived from the same calculus of quaternions. This construction is adapted to determine the cone of revolution which osculates, along a given side, to a cone of the second degree; but it will perhaps be most easily understood by considering it as serving to assign the interior pole of the small circle on a sphere, which osculates at a given point T, to a given spherical conic. Let the given cyclic arcs be AC, AC', extending from one of the two points A of their own mutual intersection to the tangent arc CTC', which is well known to be bisected at the point of contact T. On the normal arc NTP, drawn through that given point T, let fall a perpendicular arc AN; draw NC, or NC', and erect CP or $C'P$, perpendicular thereto, and meeting the normal arc in P: the point P, thus determined, will be the pole, or spherical centre of curvature, which was required.

Sir William R. Hamilton communicated a notice by Professor Young, in continuation of a paper by the same author, on the sum of eight squares, read to the Academy on 14th June last. (See Proceedings, Vol. III., p. 526.)

The principal object of the author is to shew that the formula for eight squares, as printed in the part of the Proceedings just referred to, does not admit of extension to the case of sixteen squares, or to any of the more advanced forms. The manner in which the proof of this is conducted may be briefly described as follows. As stated in the former abstract, the construction of the eight-square formula was suggested by a certain law of formation observable in that for four squares. It was under the guidance of this law that the component parts of the more advanced form were constructed and connected together; thus presenting, when completed, the eight rows of binomials which appear in the before-mentioned abstract, and which, from their construction, are necessarily such that if the quantities composing any two binomials in a row are each made zero (which is equivalent to reducing the eight squares to four), the pre-established four-square formula results.

It is easy to see, if the sixteen-square form existed, that it would necessarily involve the subordinate form for eight, exactly in the same way as this latter involves that for four : and, to be correct and general, it must yield the eight-square form when, by the suppression of four of the binomials in any row, the sixteen squares are actually reduced to eight.

Now it is shewn that these conditions cannot be accomplished ; unless, indeed, under special and peculiar limitations, which are pointed out. In proceeding to construct the sixteen-square form, providing, as we go on, for the demands of that for eight, since these are necessarily implied in those for sixteen, we find our progress, beyond a certain stage, to be impossible ; inasmuch as a step further imperatively requires that a preceding step should be modified, which modification is fatal to the accuracy of the portion already constructed. It is hence concluded that the eight-square formula cannot be a particular case of one more general for sixteen, but is itself the most advanced *modular theorem* that exists.

Towards the close of the paper the author enters upon some collateral investigations concerning squares and products; and, among other things, offers a short method of establishing, without imaginaries, a very beautiful triplet theorem discovered by John T. Graves, Esq., and printed, with its investition, in the Philosophical Magazine for 1845.

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December 13th, 1847.

JOHN ANSTER, LL. D., in the Chair.

The following letter from Mr. Staunton was read :

" *Longbridge House, near Warwick*,
" *Dec. 4th*, 1847.

" Gentlemen,—I have the pleasure of receiving, this morning, the Fyshers Irchington matrix, and lose no time in acknowledging its receipt, as I do with additional satisfaction, on account of the unanimous approbation of the exchange which has been made. I desire to convey my best thanks to the Council for their courtesy in entertaining my proposal of a measure, which seems to have placed a Limerick seal, and one of Warwickshire, in their more appropriate positions.

"I have the honour to be,
"Your obedient, humble Servant,
"WILLIAM STAUNTON.

"*The Royal Irish Academy.*"

The following letter, addressed to the President, from M. Wartmann, of Geneva, was read:

"MON CHER MONSIEUR,—J'ai bien reçu les extraits des Proceedings of the R. I. Academy et le billet que vous m'avez adressés il y a six mois. Dès lors ni les *Proceedings* promis à la Societé Vaudoise des sciences naturelles en échange des Bulletins qu'elle publie, ni les Nos. de ces mêmes Proceedings qui me manquent et que vous aviez bien voulu mè promettre (ainsi que mon ami le prof. Andrews de Belfast) ne nous sont parvenus. Mes fonctions comme professeur de physique à l'Académie de Genéve, où j'ai été appelé pour succéder a M. De la Rive, démissionnaire, ne m'ont pas permis de me rendre à Oxford où j'aurais peut-être eu le plaisir de vous rencontrer. J'ai donc pensé que vous me pardonneriez ces lignes que temoigneront du moins du vif intérêt qui la Société Vaudoise et moi-même nous portons aux publications de l'Académie.

"Toujours occupé des phénomènes si variés et si remarquables de l'induction electro-dynamique et magnétique, j'ai été amené à construire un nouveau rhéotrope à *trois* roues qui sert à volonté: 1°, à rendre discontinu un courant voltaïque dans un conducteur donné; 2°, à le rendre discontinu et de sens alternatifs; 3°, à produire et à recueillir des courants induits directs; 4°, à produire et à recueillir des courants inautorise à lui communiquer les lignes qui précèdent. Je rédige et ne tarderai pas à publier le resumé complet de mes diverses experiences et j'aurai l'honneur d'en adresser de copies, à vous, cher Monsieur, et à l'Académie, comme je l'ai fait des mes opuscules antérieurs, en signe de ma profonde considération.

"Croyez-moi, Monsieur et très-honoré Collégue, votre serviteur très-affectionné

"ELIE WARTMANN.

"*Genéve, le* 8 *Juillet*, 1847."

The Secretary presented an ancient bell from John Connellan Deane, Esq., and read the following extract from a letter addressed by him to Sir Robert Kane:

"The facts connected with my possession of it are shortly these: A pawnbroker residing in the town of Carndonagh, in the union of Inishowen, which I had charge of under the Temporary Relief Act, offered it to me for sale when I was engaged in official business in that town. It appears that it was parted with by a man to obtain food, and, as I understood, by a descendant of a family of the name of O'Donnell, who pawned it for a great number of years. It was found in the townland of Carnaclug (the Head of the Bell), which locality, they say, takes its name from the bell."

The Rev. Samuel Butcher read a paper by the Rev. C. W. Wall (V. P.), on the different kinds of cuneiform character employed by the Persians, and on the language of the inscriptions written in the first kind; of which the following is an outline:

1. A large proportion of the words of this language is utterly lost. Those preserved are to be found principally in the various forms of the Sanscrit tongue.

2. The Zend, which is a corrupt dialect and early derivative of the Sanscrit, approaches in grammatical structure

nearer than modern Sanscrit to the language of Darius, conveyed in the legends of the first kind; and the dialect of the Vedas comes yet nearer to it than does the Zend: or, in other words, the older the form we look to of the Sanscrit, the more closely it is found to agree with the language of the legends in question; the age of which legends, consequently, supplies a limit to its age.

3. Arguments derived from those legends to prove the Sanscrit a language artificially formed, in addition to, and confirmation of, those adduced in the Second Part of the author's work "On the ancient orthography of the Jews."

4. The Zend proved to be of considerably lower age than the language of the legends in question.

5. The Zend-Avesta hence shewn to be a spurious fabrication of the Parsis, or priests of Zoroaster.

6. The alphabet of the cuneatic writing of the first kind proved to be a derivative one, with regard to both the powers and the shapes of its elements.

7. Various considerations adduced tending to shew this alphabet to be, in the main, derived from the Greek one.

8. The vocalic structure of this alphabet proved to be of Shemitic origin; first, by the number of its vowel-letters (three), as well as by the circumstance of the second of those letters being used to express either *e* or *i*, and the third either *o* or *u*; and, secondly, by the traces of a yet older vocalization occasionally to be met with in this writing, according to which the letters *h*, *y*, and *w* are diverted from their proper uses to denote respectively *a*, *e* or *i*, and *o* or *u*, precisely in the same manner as the Shemitic *Haleph*, *Yod*, and *Waw* are also employed. On the other hand, the ingenious attempt of Dr. Hincks to account for the shifting of the phonetic values of the cuneiform *i* and *u* into *e* and *o* respectively, by an operation analogous to that of the Sanscrit *guna*, shewn to be defective.

9. Application of the principles laid down, under the head of the preceding observation, to the correction of the received

readings of some of the names written with the first kind of cuneiform character.

10. Comparison of the contents of the part of the Behistun inscription, in the first kind of cuneatic writing, with the historic record of Herodotus, as far as they relate to the same particulars; and confirmation thence derived of the great accuracy of the father of Pagan history.

11. The five hieroglyphs, at the bottom of the Egyptian cartouches of both Xerxes and his son Artaxerxes, examined, and shewn, in opposition to the received opinion on the subject, to be therein used, not as letters, but as symbols; and proved to denote neither "Persian," nor "great," but "great king, ruler over kings," in complete accordance with the ancient title of the Persian sovereigns preserved in the cuneatic legends of the first kind.

12. To proceed now to the consideration of the two other kinds of cuneiform writing. The space occupied by the epitaph of Cyrus in each of those kinds is but half of that it takes up in the first kind;—a very striking circumstance, which is not at all accounted for by the assumption at present in vogue, that the characters belonging to both these kinds are syllabic signs, and can be attributed solely to an essential difference in the mode of significancy between them and the elements of the first kind of this writing.

13. Some of the characters in the first and second kinds of this writing are exactly the same, and more of them are very similar. If, then, they were used as letters in both systems, no matter which may be looked upon as the later or derivative set, the framer of one of the alphabets, who borrowed the shapes of some of his letters from the other, would *a fortiori* have thence taken their powers also. But this has certainly not been done. For instance, the powers *k*, *r*, and *t*, which are ascertained to belong, respectively, to three elements of the first kind of cuneatic writing, would not at all answer, either by themselves or with any vowels joined to them, as phone-

tic values for the same characters in the second kind; as may be shewn even by the evidence of those who have attempted to make out the writing of the latter kind phonetic. The characters in question are assumed to denote in that writing respectively, *pu*, *pa*, and *jo*, by Westergaard, and *pu*, *pa*, and *yu* by Hincks.

14. With regard to M. Botta's search, in specimens of writing cognate to that of the third kind, for letters of the same power, or, as he calls them, variants or homophones, it is shewn, from his own description of the process of investigation employed by him, that what he in reality makes out are characters, not of the same phonetic, but of the same ideagraphic value; or, in other words, they are not equivalent letters, but equivalent symbols.

15. The innumerable fragments of legends in the third kind of cuneiform character, which are spread in such profusion all through the ruins of Babylon, prove this to have been the national writing of the inhabitants, as long as they continued to erect buildings, or till the capture of their city by Cyrus, after which the place fell into a state of decay, from which it never recovered. But the language of the same people, at the time of the event just specified, is also preserved to us in some chapters of the book of Daniel, as well as in other parts of the original Scriptures. We are, therefore, in possession of the very language of the Babylonian inscriptions, on the supposition of their lines consisting of groups of characters immediately expressive of words; and whenever a sufficient quantity is to be got unmutilated of any species of alphabetic writing in a known tongue, it can always be deciphered. If it be objected, with regard to the third kind of writing in question, that it is not exactly the same, but only cognate to the Babylonian kind, even admitting so much, we are still to bear in mind that the purports of several specimens of this kind are ascertained by the aid of the corresponding legends of the first kind; and besides, supposing them phone-

tically significant, we ought to be able clearly to determine, from the very outset, the powers of several of their elements, by the aid of the proper names they contain. Considering, then, the great advantages thus afforded to an analyser of the legends in the third kind of cuneiform writing, the length of time elapsed since that kind was first subjected to examination, as well as the industry, the ingenuity, and the skill that have been devoted to the investigation, it surely must have been long ago brought to a successful issue, if the writing employed in those legends were really alphabetic. But, notwithstanding all this, there has not as yet been published a single sentence of this writing translated into Chaldee, or any other language whatever.

16. The Hebrew square character certainly received not its denomination of "Chaldee" from having been derived by Ezra from Babylonian writing (a representation of the case which is fully refuted by the evidence of the coins dug out of the ruins of Jerusalem, and advocated only by the Talmuds, and that, too, with contradictory statements), but was most probably so called from having been improved in the Rabbinical school of greatest celebrity, which was held, after the destruction of Jerusalem, for a long time, in Babylonia, down to about the beginning of the eleventh century, when the Jews were driven thence by the persecutions of the Arabians. Moreover, the passages of the early Christian fathers, which have been quoted by modern divines in support of the Talmudic fiction, are shewn to have quite a different meaning from that attributed to them, and to have been strained to a sense they do not properly bear, in consequence of too great a deference having been paid at first, after the revival of learning, to the authority of the Talmuds.

17. Reference made to the copy of a specimen of Babylonian writing exhibited in the second volume of Sir Robert Ker Porter's Travels, in which the names are expressed by symbols in cartouches, not placed like seals at the beginning or

end of the document, but intermixed among the cuneatic characters. Where the names are ideagraphic, the rest of the writing must, *a fortiori*, be deemed of this nature also.

18. Argument against the supposition of the Babylonian species of cuneiform writing being phonetic, drawn from the consequence to which this hypothesis leads,—at least in the eyes of its supporters,—that alphabetic writing was known to mankind before their separation took place in the plains of Shinar. For had the sons of Noah been acquainted with such writing, no people descended from them, that is, not one of the nations on the face of the earth, could have since been found destitute of the benefit of this invaluable instrument of human learning. A people, indeed, who had long been accustomed to the employment of ideagrams might, from prejudice, refuse admittance to an alphabetic mode of designation, or, after its introduction, so, from ideagraphic habits, deteriorate and corrupt its nature, as gradually to render it useless, and finally abandon it: but none who had begun with this species of writing would ever have exchanged it for any other kind.

19. Argument against the supposition of the Babylonian kind of cuneiform writing being phonetic, from the means which it has been found necessary to resort to, for the purpose of making out values of the characters in accordance with this hypothesis.

Sir William Betham read a paper on some Etruscan coins which he had received from Mr. Cook of Parsonstown, and Mr. Charles Haliday of Dublin:

"It has often been observed, that there have been *no coins* of the ancient Irish discovered, although so many curious and interesting articles of the precious metals are of such constant occurrence; and that none are found but those of the Danish kings of the Irish cities, and the Saxon kings of England.

The circumstance is often quoted as evidence that Ireland was not a commercial country of antiquity.

"This is true as far as coins of gold and silver are concerned, for we cannot call the ring money coins, although the most ancient currency.

"It would now appear that many coins of bronze have really often been found, and that in large quantities, as well as singly; but the peasantry, thinking them of little or no value, *as brass*, have not thought it worth their while to take care of them, and any found were given to children, or sold to the brass founders for the melting pot.

"Of late, however, the anxious inquiry for antiquities has given a value to the bronze coins, and some shopkeepers and dealers in the country towns have given to the peasant finders much more for the small bronze coins than their metallic value, which has tended to make them of greater value in their eyes; and the consequence has been, that many interesting and valuable specimens have been preserved, throwing a new light on the ancient history of Ireland.

"Some years since the Rev. Dr. Sadleir exhibited a bronze coin found in Ireland, having a horse on one side, which was supposed to be Phœnician, and was then the only specimen known to have been found in Ireland. I am not aware that any record of this coin is in our Proceedings.

"I have the gratification of laying before the Academy this evening twelve bronze coins, of which ten are unquestionably Etruscan, one Roman, and one a small uncia, with a head on one side, and on the other a horse, like the coin exhibited by Dr. Sadleir, above alluded to.

"They are in the possession of Charles Haliday, Esq., a member of the Academy, who, I regret to say, is not able to appear here this evening, but has kindly allowed me to exhibit them to the Academy.

"I saw these coins about three weeks since, and was not a little astonished to see them, and to hear from Mr. Haliday that he had every reason to believe, from those from whom he obtained them, that they were found in digging the foundation of his house on Arran-quay, in this city, in the alluvial soil formerly the bed of the Liffey. He had to sink twenty feet through this soil to find a foundation, and in it were found a great many burned clay tobacco pipes, and such like matters; but he obtained nothing else till long after the house was finished, when these coins were brought to him for sale, and he purchased them, but could obtain no precise evidence where they were found. He is, however, strongly impressed with the idea they were found as above stated.

"It is remarkable that eight of the twelve specimens now exhibited to the Academy are figured in the plates of my Etruria Celtica, which I copied from a publication of Messrs. Marchi and Tessieri, Jesuits, keepers of the Kircherian Museum at Rome, the *Museum Arigoni*, published about 100 years since at Venice, and several other works on Etruscan and Italian antiquities."

[Sir W. Betham then described the coins figured in the plates of his Etruria Celtica.]

"The principal object of this paper, however, was not so much to call attention to Mr. Haliday's coins, as to bring before your notice several coins which Mr. Cook, of Birr, has placed in my hands, some of which are also undoubtedly Etruscan, and others of the class found in Britain and France, and commonly denominated British and Gaulish coins. The devices on them are evidently Etruscan, or copied from Etruscan types. The designs are as fine and well executed as the best medallist might be proud of.

"Mr. Cook's coins, which I have now the pleasure of laying before the Academy, are in a great degree free from the objection of the want of knowledge as to the locality in which they were found, inasmuch as Mr. Cook purchased them, with many others, from a shopkeeper, or dealer, of the town of Tullamore, who had purchased them, *at different* *times*, from the peasantry. There is, therefore, scarce a doubt of their having been discovered in that locality.

" I may here observe, that I have seen many hundred varieties designated by numismatists British and Gaulish coins in bronze, silver, gold, and electrum, and have not yet seen any which have not been copied from Etruscan types, most of them very closely. The Baron Donop's publication contains an immense number of varieties, but they are all of the same character.

" The bold outline of countenance of the heads on those specimens exhibits a perfection of design only to be arrived at by long experience and progress in the arts, a perfection in medalling not surpassed in the best period of Etruria, Greece, or Rome. These exceed in execution the generality of British and Gaulish coins in Ruding, and have more the character of the earlier Sicilian. A few specimens of these coins may be seen in Plate XXXIV. of Etruria Celtica, vol. ii. p. 140, and generally are in a very low style of art, and were of the period of the decline of the Celtic empire, if I may be allowed such a term. I mean the period immediately preceding the invasion of Gaul by the Romans.

" The specimens now exhibited I take to have been of a much earlier period, even many centuries before the Romans had subjugated the Etruscan power of Italy.

[Sir W. Betham here described Mr. Cook's coins.]

" I have referred to the plates of Etruria Celtica, because they are more accessible than Marchi and Tessieri, or the *Museum Arigoni*, from which the plates in that work were copied.

" I shall not attempt to draw any conclusions from these interesting specimens, but content myself with placing them before the Academy, as striking facts, important in developing the ancient history of Ireland and of Celtic Europe.

" Much has been done by the formation of the Museum of this Academy for the accumulation of facts and materials, from which may be formed, by inductive reasoning, important conclusions, likely to remove the mysteries which hang over the early history of Europe."

The Rev. Dr. Todd remarked that, although Sir William Betham had drawn no conclusion from the fact that the Etruscan coins he had exhibited were found in Ireland, yet it was evident that he wished it to be regarded as a confirmation of the views which had been put forward by him, in his *Etruria Celtica*, of an early intercourse between the Etruscans and this country.

The coins were evidently Etruscan, and, as Sir William Betham had shewn, were well known, and figured by all the best writers on the subject.

There was, therefore, no object in exhibiting them to the Academy, except from the circumstance of their being alleged to have been found in Ireland. Nevertheless, Sir William Betham had given no sufficient proof of this fact; he contented himself with the mere belief or supposition of the gentlemen from whom he had received the coins, who do not appear themselves to be able to bear any personal testimony to the fact. We should be very cautious, under these circumstances, of lending even the tacit authority of the Academy to the statement that Etruscan coins were found in Ireland; although that fact, even if proved, is not of itself of any very great importance: but in every case, great care should be taken in drawing historical conclusions from the alleged discovery of coins or other antiquities in this country. Unless the fact, and all its circumstances, be well authenticated, it is much safer to reject such conclusions, as, to say the least, uncertain and precarious. The easy admission of insufficient evidence on such a subject must obviously open a door to every kind of delusion and imposture.

In the present case, even if it had been proved that the coins were found in Ireland, it would not follow that their discovery was any evidence of intercourse between the ancient Etruscans and this country, unless it could be shown clearly that they were found in a situation to warrant such an inference. This Sir William Betham had not attempted to show. Some of the coins he exhibited are supposed to have been found in the bed of a river, along with broken tobacco pipes and other articles, of a date much later than the days of Etruscan navigators: others are said to have been bought by a shopkeeper in a provincial town, who is supposed to have procured them from the peasantry, who are supposed to have found them in the fields.

On such evidence, Dr. Todd contended that it was impossible to draw any inference from the discovery of these coins, even if it were certain that they had been really found in the bed of a river, or dug up in bogs and fields in Ireland. Sir William Betham had not given any satisfactory evidence or testimony to prove this fact; and had occupied the greater part of his paper with proving the coins to be Etruscan, which no person was disposed to deny.

Professor Allman called the attention of the Academy to the occurrence of *Hylurgus Piniperda* as destructive to the pine plantations in the county of Tipperary.

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JANUARY 10TH, 1848.

REV. HUMPHREY LLOYD, D. D., PRESIDENT, in the Chair.

HENRY CROLY, M. D., John Greene, Esq., Alexander H. Haliday, Esq., James Hartley, Esq., William Thomas Lett, Esq., F. T. C. D., George Miller, Esq., and Henry Wilson, M. D., were elected Members of the Academy.

The Secretary of the Council brought up a draft of a Memorial to His Excellency the Lord Lieutenant, praying the Government to make a special grant of £400 to the Academy, for the purchase of the Betham collection of Irish Manuscripts.

On the recommendation of the Council,

IT WAS RESOLVED,—That the sum of £100 be allocated out of the funds of the Academy, towards the purchase of the Betham MSS.

The Treasurer having opened a list, the sum of £129 9*s*. was immediately subscribed by Members of the Academy towards the same purpose.

Richard Griffith, Esq., on the part of the Shannon Commissioners, presented a collection of Antiquities lately found in that river.

Rev. John Connell presented a skull of a very peculiar shape, and a number of fragments of encaustic tiles found in the excavations lately made in the avenue leading from the Royal Hospital towards Kilmainham.

William R. Wilde, Esq., presented a remarkably round skull found in a tumulus with an urn, near Dunamaes, and also a skull discovered at Kilmainham with the iron weapons lately presented to the Academy by the Governors of the Royal Hospital.

Mr. George Yeates presented his Meteorological Journal, commencing 1st January, and ending 31st December, 1847.*

William R. Wilde, Esq., exhibited, by permission of Mrs. Beauchamp Newton, a cinerary urn found in the county

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* See Appendix, No. I.

Carlow, near Bagnalstown, and made some general remarks on Irish cinerary urns, &c.

This urn was discovered in the cutting for the Southern Railway.

It is the most beautiful of its kind ever found in Ireland. It measures only four inches across, and is of a cup-like shape, and covered with elaborate carvings. It was found full of portions of burned human bones, and was immersed in another and a larger urn.

Sir William Betham read a letter received by him from Charles Haliday, Esq., M. R. I. A.

"*Monkstown Park*,
"*Jan.* 8, 1848.

"Dear Sir William,—I have little doubt that the coins sent to the Academy were found either in pulling down my house, &c., on Arran-quay, or in preparing foundations for rebuilding. The house was purchased nearly sixty years since from Samuel Burrowes, father, I think, of the late Dean Burrowes, who had previously carried on the business of an apothecary there for many years. In this house my brother, William Haliday, resided and died, and if the coins were found in the house, they must have been his; and he never collected antiquities except those found in Ireland.

"These coins were brought to me by the person who overlooked the workmen, and I think he then mentioned they were 'part of some things which had been found.' At the time I was much engaged by pressing and most important business, and not being a collector of coins or antiquities, I paid little attention to the matter until, casually meeting my old friend, Dr. Petrie, in a railway carriage, it was brought to my recollection by an anecdote of his ardent pursuit of some coins at an early period of life. A few days after I selected them from the drawer into which I had thrown them,

Fig. 1

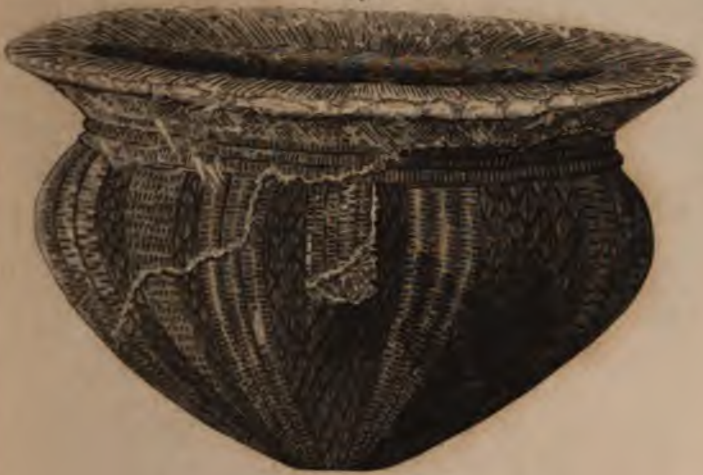
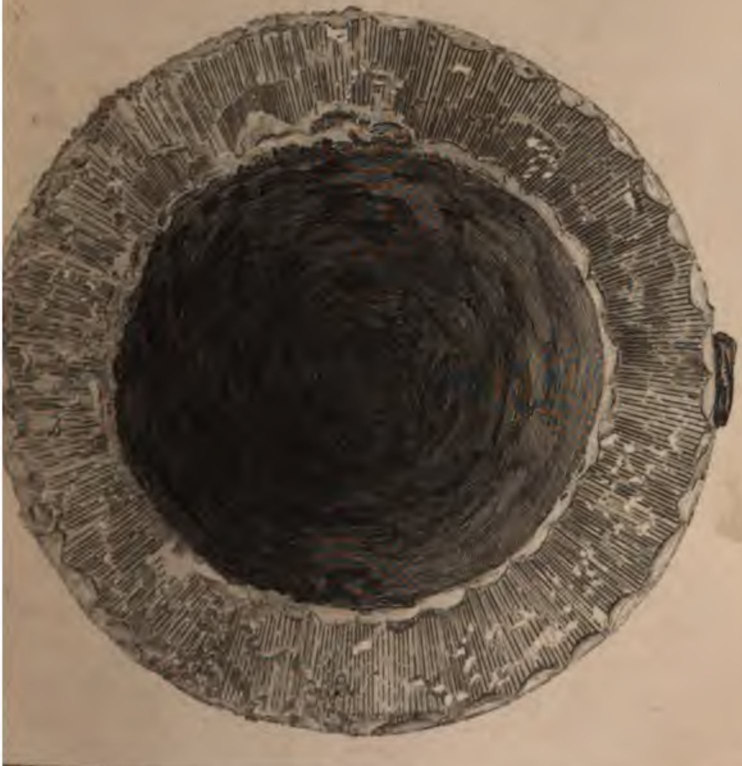


Fig 2



J. [illegible] Sc. Dub.

amongst some town tokens, &c., and sent them to him, and neither saw him nor heard of the coins for two or three months, when he informed me they were Etruscan, and pointed out to me the plates of them in your work.

"I felt that you would be pleased to see them, and the first opportunity I had of mentioning the circumstance was at my own house, where, before dinner, I showed them to you, the Rev. Mr. Edgeworth, and Dr. Henry, President of the Belfast College, &c. They never were seen by any other person, nor were they ever out of my possession from the time I received them until I sent them to the Academy, in consequence of a note from Mr. Clibborn to me; and to Dr. Petrie I stated the particulars as I mentioned them to you.

"The only other things I got, when I subsequently made inquiries to observe where the coins were found, were some of what they termed Danish pipes, acknowledged to be found in digging the foundations of the warehouse attached to the house, and which foundations they were compelled to sink very deep, and ultimately to complete by driving piles into the soft soil,—evidently part of the river bank.

"I never attend evening meetings, or, assuredly, I would attend the Royal Irish Academy. If I ever supposed that we could procure positive evidence that these coins were dug up from a considerable depth, the fact could not be used in support of any theory, except in connexion with other facts. I was interested by the extraordinary fact that they were chiefly coins figured in Etruria Celtica, and this rendered me desirous that you should see them.

"Believe me, my dear Sir William,
"Very truly your's,
"CHARLES HALIDAY.

"*Sir W. Betham,*
"*&c. &c.*"

Mr. George Yeates communicated the following notice of a Meteor:

On the 13th of December, 1847, while walking on the South Circular Road, near the Richmond Penitentiary, about 11 o'clock at night, he observed a remarkable meteor; it first appeared in the west, very brilliant, and about 30° above the horizon; it moved rapidly towards the observer, passing between him and the above-named building, in an easterly direction; disappeared about 500 yards off, and a slight noise from it was distinctly heard as it passed.

The evening was rather cloudy; wind southerly.

Barometer, ...	29.716
Thermometer, ...	53°

Sir William Rowan Hamilton gave an account of some applications of Quaternions to questions connected with the Rotation of a Solid Body.

I. It was shown to the Academy in 1845, among other applications of the Calculus of Quaternions to the fundamental problems of Mechanics, that the composition of statical couples, of the kind considered by Poinsot, as well as that of ordinary forces, admits of being expressed with great facility and simplicity by the general methods of this Calculus. Thus, the general conditions of the equilibrium of a rigid system are included in the following formula, which will be found numbered as equation (20) of the abstract of the Author's communication of December 8, 1845, in the Proceedings of the Academy for that date:

$$\Sigma \,.\, \alpha\beta = -c. \tag{1}$$

In the formula thus cited, α is the *vector of application* of a force denoted by the other vector β; and the scalar symbol, $-c$, which is equated to the sum $\alpha\beta + \alpha'\beta' + \ldots$ of all the quaternion products $\alpha\beta$, $\alpha'\beta'$, .. of all such pairs of vectors, or directed lines α and β, is, in the case of equilibrium, independent of the position of the point from which all the vectors

$\alpha, \alpha', ..$ are drawn, as from a common origin, to the points of application of the various forces, $\beta, \beta', ..$ This requires that the two following conditions should be separately satisfied,

$$\Sigma\beta = 0; \ \Sigma V.\alpha\beta = 0; \tag{2}$$

which accordingly coincide with the two equations marked (18) of the abstract just referred to. The former of these two equations, $\Sigma\beta = 0$, expresses that the applied *forces* would balance each other, if they were all transported, without any changes in their intensities or directions, so as to act at any one common point, such as the origin of the vectors α; and the latter equation, $\Sigma V.\alpha\beta = 0$, expresses that all the *couples* arising from such transport of the forces, or from the introduction of a system of new and opposite forces, $-\beta$, all acting at the same common origin, would also balance each other: the *axis* of any one such couple being denoted, in magnitude and in direction, by a symbol of the form $V.\alpha\beta$. When either of these two vector-sums, $\Sigma\beta$, $\Sigma V.\alpha\beta$, is different from zero, the system cannot be in equilibrium, at least if there be no fixed point nor axis; and in this case, the quaternion quotient which is obtained, by dividing the latter of these two vector-sums by the former, has a remarkable and simple signification. For, if this division be effected by the general rules of this calculus, in such a manner as to give a quotient expressed under the original and standard form of a *quaternion*, as assigned by Sir William R. Hamilton in his communication of the 13th of November, 1843; that is to say, if the quotient of the two vectors lately mentioned be reduced by those general rules to the fundamental *quadrinomial form*,

$$\frac{\Sigma V.\alpha\beta}{\Sigma\beta} = w + ix + jy + kz, \tag{3}$$

where i, j, k are the Author's *three co-ordinate imaginaries*, or *rectangular vector-units*, namely, symbols satisfying the equations,

$$i^2 = j^2 = k^2 = ijk = -1, \tag{4}$$

which have already been often adduced and exemplified by him, in connexion with other geometrical and physical researches; then the *four constituent numbers*, w, x, y, z, of this quaternion (3), will have, in the present question, the meanings which we are about to state. The algebraically real or *scalar* part of the quaternion (3), namely, the number

$$w = S(\Sigma V . \alpha\beta \div \Sigma\beta), \tag{5}$$

which is independent of the imaginary or symbolic coefficients i, j, k, will denote the (real) quotient which might be otherwise obtained by *dividing the moment of the principal resultant couple by the intensity of the resultant force;* with the known direction of which force the axis of this *principal* (and known) couple coincides, being the line which is known by the name of the *central axis* of the system. And the three other numerical constituents of the same quaternion (3), namely, the three real numbers x, y, z, which are multiplied respectively by those symbolic coefficients i, j, k, in the algebraically imaginary or *vector* part of that quaternion, namely, in the part

$$ix + jy + kz = V(\Sigma V . \alpha\beta \div \Sigma\beta), \tag{6}$$

are the three real and rectangular *co-ordinates of the foot of the perpendicular let fall from the assumed origin* (of vectors or of co-ordinates) *on the central axis of the system.* These co-ordinates vanish, if the origin be taken on that axis; and then the direction of the resultant force coincides with that of the axis of the resultant couple: a coincidence of which the condition may accordingly be expressed, in the notation of this Calculus, by the formula

$$0 = V(\Sigma V . \alpha\beta \div \Sigma\beta); \tag{7}$$

whereas the second member of this formula (7) is in general a vector-symbol, which denotes, in length and in direction, the perpendicular let fall as above. In the case where it is possible to reduce the system of forces to a single resultant force, unaccompanied by any couple, the scalar part of the same quaternion (3) vanishes; so that we may write for this case the equation,

$$0 = S(\Sigma V . \alpha\beta \div \Sigma\beta); \tag{8}$$

which agrees with the equation (19) of the abstract of December, 1845, and in which the second member is in general a scalar symbol, denoted lately by w, and having the signification already assigned. When the resultant force vanishes, without the resultant couple vanishing, then the denominator or divisor $\Sigma\beta$ becomes null, in the fraction or quotient (3), while the numerator or dividend, $\Sigma V . \alpha\beta$, continues different from zero; and when both force and couple vanish, we fall back on the equations (18) of the former abstract just cited, or on those marked (2) in the present communication, as the conditions of equilibrium of a free but rigid system. Finally, the scalar symbol

$$c = -\Sigma S . \alpha\beta, \tag{9}$$

which enters with its sign changed into the second member of the formula (1), and which, when the resultant $\Sigma\beta$ of the forces β vanishes, receives a value independent of the assumed origin of the vectors α, has also a simple signification; for (according to a remark which was made on a former occasion), there appears to be a propriety in regarding this scalar symbol c, or the negative of the sum of the scalar parts of all the quaternion products of the form $\alpha\beta$, as an expression which denotes the total *tension* of the system. In the foregoing formulæ the letters S and V are used as characteristics of the operations of taking respectively the *scalar* and the *vector*, considered as the two *parts* of any quaternion expression; which parts may still be sometimes called the (algebraically) *real* and (algebraically) *imaginary* parts of that expression, but of which *both* are *always*, in this theory, entirely and easily *interpretable:* and in like manner, in the remainder of this Abstract, the letters T and U shall indicate, where they occur, the operations of taking separately the *tensor* and the *versor*, regarded as the two principal *factors* of any such quaternion.

11. To apply to problems of *dynamics* the foregoing *statical* formulæ, we have only to introduce, in conformity with a well-known principle of mechanics, the consideration of the equilibrium which must subsist between the forces lost and gained. That is, we are to substitute for the symbol β, in the equations (1) or (2), the expression

$$\beta = m\left(\phi - \frac{\mathrm{d}^2\alpha}{\mathrm{d}t^2}\right); \qquad (10)$$

where m denotes the mass of that part or element of the system which, at the time t, has α for its vector of position, and consequently $\frac{\mathrm{d}^2\alpha}{\mathrm{d}t^2}$ for its vector of acceleration; while the new vector-symbol ϕ denotes the accelerating force, or $m\phi$ denotes the moving force applied, direction as well as intensity being attended to. Thus, instead of the two statical equations (2), we have now the two following dynamical equations, for the motion of a free but rigid system:

$$\Sigma \, . \, m \frac{\mathrm{d}^2\alpha}{\mathrm{d}t^2} = \Sigma \, . \, m\phi; \qquad (11)$$

$$\Sigma \, . \, mV . \, \alpha \frac{\mathrm{d}^2\alpha}{\mathrm{d}t^2} = \Sigma \, . \, mV . \, \alpha\phi; \qquad (12)$$

of which the former contains the law of motion of the centre of gravity, and the latter contains the law of the description of areas. If the rigid system have one point fixed, we may place at this point the origin of the vectors α; and in this case the equation (11) disappears from the statement of the question, but the equation (12) still remains: while the condition that the various points of the system are to preserve unaltered their distances from each other, and from the fixed point, is expressed by the formula

$$\frac{\mathrm{d}\alpha}{\mathrm{d}t} = V . \, \iota\alpha, \qquad (13)$$

where the vector-symbol ι denotes a straight line drawn in the direction of the axis of momentary rotation, and having a length which represents the angular velocity of the system; so that this vector ι is generally a function of the time t, but is always, at any one instant, the same for all the points of the body, or of the rigid system here considered. The equation (12) thus gives, by an immediate integration, the following expression for the law of areas:

$$\Sigma \,.\, m\alpha V \,.\, \iota\alpha = \gamma + \Sigma \,.\, m V\!\int \alpha\phi \,\mathrm{d}t; \tag{14}$$

where γ is a constant vector; and if we operate on the same equation (12) by the characteristic $2 S\!\int \iota \mathrm{d}t$, we obtain an expression for the law of living forces, under the form:

$$\Sigma \,.\, m(V \,.\, \iota\alpha)^2 = -h^2 + 2\Sigma \,.\, m S\!\int \iota\alpha\phi \,\mathrm{d}t; \tag{15}$$

where h is a constant scalar. The integrals with respect to the time may be conceived to begin with $t = 0$; and then the vector γ will represent the *axis of the primitive couple*, or of the couple resulting from all the moving forces due to the initial velocities of the various points of the body; and the scalar h will represent the *square root of the primitive living force* of the system, or the square root of the sum of all the living forces obtained by multiplying each mass into the square of its own initial velocity. Again, the equation (13) gives, by differentiation,

$$\frac{\mathrm{d}^2\alpha}{\mathrm{d}t^2} = V \,.\, \iota \frac{\mathrm{d}\alpha}{\mathrm{d}t} + V \,.\, \frac{\mathrm{d}\iota}{\mathrm{d}t}\alpha = \iota V \,.\, \iota\alpha - V \,.\, \alpha \frac{\mathrm{d}\iota}{\mathrm{d}t}; \tag{16}$$

and for any two vectors α and ι, we have, by the general rules of this Calculus, the transformations,

$$\left.\begin{aligned} &V \,.\, \alpha(\iota V \,.\, \iota\alpha) = V \,.\, \iota(\alpha V \,.\, \iota\alpha) = \tfrac{1}{2} V \,.\, (\iota\alpha)^2 \\ &= S \,.\, \iota\alpha \,.\, V \,.\, \iota\alpha = \tfrac{1}{2} V \,.\, \iota(\alpha\iota\alpha) = -\tfrac{1}{2} V \,.\, \alpha(\iota\alpha\iota); \end{aligned}\right\} \tag{17}$$

therefore, by (12) and (14),

$$\left.\begin{aligned} &\Sigma \,.\, m\alpha V \,.\, \alpha \frac{\mathrm{d}\iota}{\mathrm{d}t} + \Sigma \,.\, m V \,.\, \alpha\phi = V \,.\, \iota \Sigma \,.\, m\alpha V \,.\, \iota\alpha \\ &\qquad = V \,.\, \iota\gamma + \Sigma \,.\, m V \,.\, \iota V\!\int \alpha\phi \,\mathrm{d}t. \end{aligned}\right\} \tag{18}$$

Hence also the *time t*, elapsed between any two successive stages of the rotation of the body, may in various ways be expressed by a definite integral; we may, for example, write generally,

$$t = \int \frac{2\Sigma \,.\, maV.\, a\mathrm{d}\iota}{\Sigma V.\, m(\,(\iota a)^2 + 2\phi a)}\,; \qquad (19)$$

the scalar element d*t* of this integral being thus expressed as the quotient of a vector element, divided by another vector; before finding an available expression for which scalar quotient it will, however, be in general necessary to find previously the geometrical manner of motion of the body, or the law of the succession of the positions of that body or system in *space*. It may also be noticed here, that the comparison of the integrals (14) and (15) gives generally the relation:

$$S.\,\iota\gamma + h^2 = \Sigma \,.\, m S\!\int\!\iota a\phi \mathrm{d}t. \qquad (20)$$

III. When no accelerating forces are applied, or when such forces balance each other, we may treat the vector ϕ as vanishing, in the equations of the last section of this abstract; which thus become, for the *unaccelerated rotation of a solid body about a fixed point*, the following:

$$\Sigma \,.\, m a V.\, \iota a = \gamma\,; \qquad (21)$$

$$\Sigma \,.\, m(V.\, \iota a)^2 = -\, h^2\,; \qquad (22)$$

$$\Sigma \,.\, maV.\, a\mathrm{d}\iota = V.\, \iota\gamma \mathrm{d}t\,; \qquad (23)$$

which result from (14) (15) (18), by supposing $\phi = 0$, or, more generally

$$\Sigma \,.\, mV.\, a\phi = 0, \qquad (24)$$

that is, by reducing the differential equation (12) of the second order, for the motion of the rigid system, to the form

$$\Sigma \,.\, mV.\, a\,\frac{\mathrm{d}^2 a}{\mathrm{d}t^2} = 0. \qquad (25)$$

At the same time the general relation (20) reduces itself to the following:

$$S.\,\iota\gamma + h^2 = 0\,; \qquad (26)$$

which may accordingly be obtained by a combination of the integrals (21) and (22); and the vector part of the quaternion $\iota\gamma$, of which the scalar part is thus $= -h^2$, may be expressed by means of the formula:

$$2V.\iota\gamma = V\Sigma.m(\iota\alpha)^2 = V.\iota\Sigma.m\alpha\iota\alpha; \tag{27}$$

which gives, by one of the transformations (17),

$$V.\iota\gamma = V.\iota\Sigma.m\alpha S.\alpha\iota; \tag{28}$$

so that we have, by (13) and (23),

$$\Sigma.m\alpha V.\alpha\mathrm{d}\iota = \Sigma.m\mathrm{d}\alpha S.\alpha\iota. \tag{29}$$

But also, by (21), because $S.\iota\mathrm{d}\alpha = 0$, we have

$$\Sigma.m\alpha V.\alpha\mathrm{d}\iota = -\Sigma.m\mathrm{d}\alpha V.\alpha\iota + \Sigma.m\alpha\iota\mathrm{d}\alpha;$$

we ought, therefore, to find that

$$\Sigma.m(\mathrm{d}\alpha.\alpha\iota - \alpha\iota.\mathrm{d}\alpha) = 0,$$

or that

$$0 = V\Sigma.m(V.\iota\alpha.\mathrm{d}\alpha); \tag{30}$$

which accordingly is true, by (13), and may serve as a verification of the consistency of the foregoing calculations.

IV. We propose now briefly to point out a few of the *geometrical* consequences of the formulæ in the foregoing section, and thereby to deduce, in a new way, some of the known properties of the rotation to which they relate; and especially to arrive anew at some of the theorems of Poinsot and Mac Cullagh. And first, it is evident on inspection that the equation (22) expresses that *the axis ι of instantaneous rotation is a semidiameter of a certain ellipsoid, fixed in the body, but moveable with it;* and having this property, that if the constant living force h^2 be divided by the square of the length of any such semidiameter ι, the quotient is the *moment of inertia of the body with respect to that semidiameter as an axis:* since the general rules of this calculus, when applied to the formula (22), give for this quotient the expression,

$$\Sigma.m(TV.\alpha U\iota)^2 = -h^2\iota^{-2} = h^2T\iota^{-2}; \tag{31}$$

where $TV.\alpha U\iota$ denotes the length of the perpendicular let fall, on the axis ι, from the extremity of the vector α, that is, from the point or element of the body of which the mass is m. In the next place, the equation (26), which is of the first degree in ι, may be regarded as representing the *tangent plane* to the ellipsoid (22), at the extremity of the semidiameter ι: because this equation is satisfied by that semidiameter or vector ι, when we attribute to it the same value (in length and in direction) as before; and because if we change this vector ι to any infinitely near vector $\iota + \delta\iota$, consistent with the equation (22) of the ellipsoid, this near value of the vector will also be compatible with the equation (26) of the plane; for when the variation of the equation (22) is thus taken (by the rules of the present calculus), and is combined with the equation (21), it agrees with the equation (26) in giving

$$S.\gamma\delta\iota = 0. \qquad (32)$$

But the plane (26) is *fixed in space*, on account of the constant vector γ and the constant scalar h, which were introduced by integration as above; consequently *the ellipsoid* (22) *rolls* (without gliding) *on the fixed plane* (26), *carrying with it the body in its motion*, and having its centre fixed at the fixed point of that body, or system, while the *semidiameter of contact* ι represents, in length and in direction, the *axis of the momentary rotation*. This is only a slightly varied form of a theorem discovered by Poinsot, which is one of the most beautiful of the results wherewith science has been enriched by that geometer: for the ellipsoid (22), which has here presented itself as a mode of *constructing the integral equation which expresses the law of living force of the system*, and which might for that reason be called the *ellipsoid of living force*, is easily seen to be concentric with, and similar to, the *central ellipsoid* of Poinsot, and to be similarly situated in the body. It may, however, be regarded as a somewhat remarkable circumstance, and one characteristic of the present method of calculation, that *it has not been necessary, in the foregoing process, to* *make any use of the three axes of inertia*, nor even to assume any knowledge of the *existence* of those important axes; nor to make any other reference to any *axes of co-ordinates* whatsoever. The result of the calculation might be expressed by saying that "the ellipsoid of living force rolls on a plane parallel to the plane of areas;" and nothing farther, at this stage, might be supposed known respecting that ellipsoid (22), or respecting any other ellipsoid, than that it is a closed surface represented by an equation of the second degree. With respect to the *path of the axis of momentary rotation* ι, *within the body*, it is evident, from the equations (21), (22), that this path, or locus, is a *cone of the second degree*, which has for its equation the following:

$$\gamma^2 \Sigma . m(V . \iota a)^2 = - h^2 (\Sigma . m a V . \iota a)^2 ; \qquad (33)$$

where the symbol γ^2, by one of the fundamental principles of the present calculus, is a certain negative scalar, namely, the negative of the square of the number which expresses the length of the vector γ, and which (in the present question) is constant by the law of the areas. Thus, according to another of Poinsot's modes of presenting to the mind a sensible image of the motion of the body, that motion of rotation may be conceived as the *rolling of a cone*, namely, of this cone (33), which is fixed in the body, but moveable therewith, on a certain other cone, which is the fixed locus in space of the instantaneous axis ι.

V. But we might also inquire, what is the *relative locus*, or what is the path *within* the body, of the vector γ, which has, by the law of areas, *a fixed direction*, as well as a *fixed length in space:* and thus we should be led to reproduce some of the theorems discovered by Mac Cullagh, in connexion with this celebrated problem of the rotation of a solid body. The equations (26) and (32) would give this other formula,

$$S . \iota \delta \gamma = 0 ; \qquad (34)$$

and thus would shew that the vector γ is (in the body) a variable semidiameter of an ellipsoid *reciprocal* to that ellipsoid (22) of which the vector ι has been seen to be a semidiameter; and that these two vectors γ and ι are *corresponding semidiameters* of these two ellipsoids. The tangent plane to the new ellipsoid, at the extremity of the semidiameter γ (which extremity is fixed in space, but moveable within the body), is perpendicular to the axis ι of instantaneous rotation, and intercepts upon that axis a portion (measured from the centre) which has its length expressed by $h^2\, T\iota^{-1}$, and which is, therefore, inversely proportional to the momentary and angular velocity (denoted here by $T\iota$), as it was found by Mac Cullagh to be. To find the *equation* of this reciprocal ellipsoid we have only to deduce, by the processes of this calculus, from the linear equation (21), an expression for the vector γ in terms of the vector ι, and then to substitute this expression in the equation (26). Making, for abridgment,

$$\left.\begin{aligned} n^2 = -\Sigma\,.\,m\alpha^2\,;\ n'^2 = -\Sigma\,.\,mm'(V.\,\alpha\alpha')^2\,; \\ n''^2 = +\Sigma\,.\,mm'm''(S.\,\alpha\alpha'\alpha'')^2\,; \end{aligned}\right\} \qquad (35)$$

so that n, n', n'', are real or scalar quantities, because the square of a vector is negative; and introducing a characteristic of operation σ, defined by the symbolic equation,

$$\sigma = \Sigma\,.\,m\alpha S\,.\,\alpha, \text{ or } \sigma\iota = \Sigma\,.\,m\alpha S\,.\,\alpha\iota\,; \qquad (36)$$

it is not difficult to show, first, that

$$(\sigma^2 + n^2\sigma + n'^2)\,\iota = -\Sigma\,.\,mm'\,V.\,\alpha\alpha'\,S.\,\alpha\alpha'\iota\,; \qquad (37)$$

and then that the *symbol σ is a root of the symbolic and cubic equation,*

$$\sigma^3 + n^2\sigma^2 + n'^2\sigma + n''^2 = 0\,; \qquad (38)$$

in the sense that *the operation denoted by the first member of this symbolic equation* (38) *reduces every vector ι, on which it is performed, to zero.* But the linear equation (21) may be thus written:

$$(\sigma + n^2)\,\iota = \gamma\,; \qquad (39)$$

it gives, therefore, by (38),

$$(n^2n'^2 - n''^2)\iota = (\sigma^2 + n'^2)\gamma : \tag{40}$$

that is, by (37) and (36),

$$(n''^2 - n^2n'^2)\iota = n^2\Sigma\,.\,maS\,.\,a\gamma + \Sigma\,.\,mm'V\,.\,aa'S\,.\,aa'\gamma. \tag{41}$$

Such being, then, the solution of this linear equation (21) or (39), the sought equation of Mac Cullagh's ellipsoid becomes, by (26),

$$(n^2n^2 - n''^2)h^2 = n^2\Sigma\,.\,m(S\,.\,a\gamma)^2 + \Sigma\,.\,mm'(S\,.\,aa'\gamma)^2 ; \tag{42}$$

and we see that the following inequality must hold good:

$$n^2n'^2 - n''^2 > 0. \tag{43}$$

If then a new and constant scalar g be determined by the condition,

$$(n^2n'^2 - n''^2)h^2 + g^2\gamma^2 = 0, \tag{44}$$

(where γ^2 is still equal to the same constant and negative scalar as before), we may represent the *internal conical path*, or relative locus, of the vector γ in the body, by the equation:

$$0 = g^2\gamma^2 + n^2\Sigma\,.\,m(S\,.\,a\gamma)^2 + \Sigma\,.\,mm'(S\,.\,aa'\gamma)^2. \tag{45}$$

We see then, by this analysis, that *the straight line γ which is drawn through the fixed centre of rotation, perpendicular to the plane of areas, describes within the body another cone of the second degree:* while the *extremity* of the same vector γ, which is a *fixed point in space, describes, by its relative motion, a spherical conic in the body*, namely, the curve of intersection of the cone (45) and the sphere (44): which agrees with Mac Cullagh's discoveries. Again, the normal to the cone (45), which corresponds to the side γ, has the direction of the vector determined by the following expression:

$$\theta = \iota + h^2\gamma^{-1} ; \tag{46}$$

and this new vector θ is always situated in the plane of areas, and is the side of contact of that plane with another cone of the second degree in the body, which is *reciprocal* to the cone (45), and was studied by both Poinsot and Mac Cullagh. But it would far exceed the limits of the present communication, if the author were to attempt here to call into review the labours of all the eminent men who, since the time of Euler, have treated, in their several ways, of the rotation of a solid body. He desires, however, before he concludes this sketch, to show how his own methods may be employed to assign the values of the three principal moments, and the positions of the three principal axes of inertia; although it has not been necessary for him, so far, on the plan which he has pursued, to make any use of those axes.

VI. Let us, then, inquire under what conditions the body can continue to revolve, with a constant velocity, round a permanent axis of rotation. The condition of such a *double* permanence, of both the direction and the velocity of rotation, is completely expressed, on the present plan, by the one differential equation,

$$\frac{d\iota}{dt} = 0; \tag{47}$$

that is, in virtue of the formula (23), by

$$V.\iota\gamma = 0; \tag{48}$$

or, on account of (28) and (36), by this other equation,

$$(\sigma + s)\iota = 0, \tag{49}$$

where σ is the characteristic of operation lately employed, and s is a scalar coefficient, which must, if possible, be so determined as to allow the following symbolic expression for the sought permanent axis of rotation, namely,

$$\iota = (\sigma + s)^{-1}\, 0, \tag{50}$$

to give a value different from zero, or to represent an actual vector ι, and not a null one. Now if we assumed any actual vector κ, such that

$$(\sigma + s)\iota = \kappa, \tag{51}$$

we should find, by the foregoing Section of this Abstract, and especially by the equations (37) and (38), a result of the form,

$$(s^3 - n^2 s^2 + n'^2 s - n''^2)\iota = \sigma'\kappa, \qquad (52)$$

where σ' is a new characteristic of operation, such that

$$\sigma' = \sigma^2 - s\sigma + s^2 + n^2(\sigma - s) + n'^2, \qquad (53)$$

and that, therefore,

$$\sigma'\kappa = s^2\kappa + s\Sigma \,.\, maV \,.\, a\kappa - \Sigma \,.\, mm'V \,.\, aa'S \,.\, aa'\kappa; \qquad (54)$$

so that the solution (41) of the linear equation (39) is included in this more general result, which gives, for any arbitrary value of the number s, the symbolic expression:

$$(\sigma + s)^{-1} = (s^3 - n^2 s^2 + n'^2 s - n''^2)^{-1}\sigma'. \qquad (55)$$

Hence the condition for the non-evanescence of the expression (50), or the distinctive character of the permanent axes of rotation, is expressed by the cubic equation,

$$s^3 - n^2 s^2 + n'^2 s - n''^2 = 0. \qquad (56)$$

The inequality (43) shows immediately that this equation (56) is satisfied by at least *one* real value of s, between the limits 0 and n^2; and an attentive examination of the composition (35) of the coefficients of the same cubic equation in s, would prove that this cubic has in general *three* real and unequal roots, between the same two limits; which roots we may denote by s_1, s_2, s_3. Assuming next any *arbitrary* vector κ, and deriving from it two other vectors, κ' and κ'', by the formulæ

$$\Sigma \,.\, maV \,.\, a\kappa = \kappa'; \; -\Sigma \,.\, mm'V \,.\, aa'S \,.\, aa'\kappa = \kappa''; \qquad (57)$$

making also

$$\left.\begin{aligned} \iota_1 &= s_1^2\kappa + s_1\kappa' + \kappa'', \\ \iota_2 &= s_2^2\kappa + s_2\kappa' + \kappa'', \\ \iota_3 &= s_3^2\kappa + s_3\kappa' + \kappa''; \end{aligned}\right\} \qquad (58)$$

we shall thus have, in general, a system of three rectangular vectors, ι_1, ι_2, ι_3, in the directions of the *three principal axes*. For first they will be, by (54), the three results of the form $\sigma'\kappa$, obtained by changing s, successively and separately, to the three roots of the ordinary cubic (56); but by the manner of dependence (53) of the characteristic σ' on σ and s, and by the symbolic equation of cubic form (38) in σ, we have, if s be any one of those three roots of (56), the relation

$$(\sigma + s)\sigma'\kappa = 0\,; \tag{59}$$

consequently the three vectors (58) are such that

$$0 = (\sigma + s_1)\iota_1 = (\sigma + s_2)\iota_2 = (\sigma + s_3)\iota_3. \tag{60}$$

Each of the vectors, ι_1, ι_2, ι_3, is therefore, by (49), adapted to become a permanent axis of rotation of the body; while the foregoing analysis shows that in general no other vector ι, which has not the direction of one of those three vectors (58), or an exactly opposite direction, is fitted to become an axis of such permanent rotation. And to prove that these three axes are in general at right angles to each other, or that they satisfy in general the three following equations of perpendicularity,

$$0 = S.\iota_1\iota_2 = S.\iota_2\iota_3 = S.\iota_3\iota_1, \tag{61}$$

we may observe that, for any two vectors ι, κ, the form (36) of the characteristic σ gives,

$$S.\kappa\sigma\iota = \Sigma.mS.\kappa a\,S.a\iota = S.\iota\sigma\kappa, \tag{62}$$

and therefore, for any scalar s,

$$S.\kappa(\sigma + s)\iota = S.\iota(\sigma + s)\kappa\,; \tag{63}$$

consequently the two first of the equations (60) give (by changing ι, κ, s to ι_2, ι_1, s_1),

$$(s_1 - s_2)\,S.\iota_1\iota_2 = 0\,; \tag{64}$$

and therefore they conduct to the first equation of perpendicularity (61), or serve to show that the two axes, ι_1 and ι_2, are mutually rectangular, at least in the general case, when the two corresponding roots, s_1 and s_2, of the equation (56), are unequal. The equations (48) and (32), namely, $V.\iota\gamma = 0$, $S.\gamma\delta\iota = 0$, show also that these three rectangular axes of inertia are in the directions of the *axes of the ellipsoid* (22), which has presented itself as a sort of construction of the law of living force of the system; and a *common property* of these three rectangular directions, which in general belongs *exclusively* to them, and to their respectively opposite directions, may be expressed by the rules of this calculus under the very simple form,

$$0 = V\Sigma . m(\iota\alpha)^2; \tag{65}$$

or under the following, which is equivalent thereto,

$$\Sigma . m(\iota\alpha)^2 = \Sigma . m(\alpha\iota)^2. \tag{66}$$

With respect to the geometrical and physical significations of the three values of the positive scalar s, the equation (49) gives

$$s\iota^2 + S . \iota\sigma\iota = 0; \tag{67}$$

and consequently by (36), and by the general rules of this calculus,

$$s = \Sigma . m(S . \alpha U\iota)^2 = \Sigma . mx^2, \tag{68}$$

if x denote the perpendicular distance of the mass m from the plane drawn through the fixed point of the body, in a direction perpendicular to the axis ι. We may therefore write the following expressions for the three roots of the cubic (56):

$$s_1 = \Sigma . mx^2; \quad s_2 = \Sigma . my^2; \quad s_3 = \Sigma . mz^2; \tag{69}$$

if xyz denote (as usual) three rectangular coordinates, of which the axes here coincide respectively with the directions of $\iota_1, \iota_2, \iota_3$; and we see that the *three principal moments* of inertia, or those relative to these three axes, are the three sums,

$$s_2 + s_3, \quad s_3 + s_1, \quad s_1 + s_2, \tag{70}$$

of pairs of roots of the cubic equation which has been employed in the present method. At the same time, the conditions above assigned for the directions of those three axes take easily the well-known forms,

$$0 = \Sigma . mxy = \Sigma . myz = \Sigma . mzx, \tag{71}$$

if (for the sake of comparison with known results) we change the vectors $\alpha, \alpha', \ldots$ of the masses $m, m', \ldots$ to the expressions

$$\alpha = ix + jy + kz, \quad \alpha' = ix' + jy' + kz', \ldots \tag{72}$$

where xyz are the rectangular co-ordinates of m, and ijk are the three original and fundamental symbols of the present Calculus, denoting generally three rectangular vector-units, and subject to the laws of symbolical combination which were communicated to the Academy by the author in 1843, and are included in the formula (4) of the present Abstract. And then, by (35), the coefficients of the cubic equation (56) will take the following forms, which easily admit of being interpreted, or of being translated into geometrical enunciations:

$$\left.\begin{aligned} n^2 &= \Sigma \,.\, m(x^2 + y^2 + z^2); \\ n'^2 &= \Sigma \,.\, mm' \{(yz' - zy')^2 + (zx' - xz')^2 + (xy' - yx')^2\}; \\ n''^2 &= \Sigma \,.\, mm'm'' \{(yz' - zy')x'' + (zx' - xz')y'' + (xy' - yx')z''\}^2. \end{aligned}\right\} \tag{73}$$

In fact, the first of these three expressions is evidently the sum of the three quantities (69); and it is not difficult to prove that, under the conditions (71), the second expression (73) is equal to the sum of the three binary products of those three quantities; and that the third expression (73) is equal to their continued or ternary product: in such manner as to give

$$\left.\begin{aligned} s_1 + s_2 + s_3 &= n^2; \\ s_1 s_2 + s_2 s_3 + s_3 s_1 &= n'^2; \\ s_1 s_2 s_3 &= n''^2. \end{aligned}\right\} \tag{74}$$

Perhaps, however, it may not have been noticed before, that expressions possessing so *internal* a character as do these three expressions (73), and admitting of such simple *interpretations* as they do, without any *previous* reference to the axes of inertia, or indeed to *any axes* (since all is seen to depend on the *masses and mutual distances* of the several points or elements of the system), are the coefficients of a cubic equation which has the well-known sums, $\Sigma \,.\, mx^2$, $\Sigma \,.\, my^2$, $\Sigma \,.\, mz^2$, referred to the three principal planes, for its three roots. In the method of the present communication, those expressions (73), or rather the more concise but equivalent expressions (35), have been seen to offer themselves as coefficients of a *symbolic equation of the third degree* (38), which is satisfied by a certain *characteristic of operation* σ, connected with the solution of a certain other symbolic but *linear* equation: and the Author may be permitted to mention that this is only a particular (though an important) application of a general method, which he has for a considerable time past possessed, for the solution of those linear equations to which the Calculus of Quaternions conducts. To those who have perused the foregoing sections of this Abstract, and who have also read with attention the Abstract of his communication of July, 1846, published in the Proceedings of that date, he conceives that it will be evident that *for any fixed point A of any solid body* (or rigid system), *there can be found* (indeed in more ways than one) *a pair of other points B and C, which are likewise fixed in the body, and are such that the square-root of the moment of inertia round any axis AD is geometrically constructed or represented by the line BD, if the points A and D be at equal distances from C.*

VII. Finally, he desires to mention here one other theorem respecting rotation, which is indeed more of a geometrical than of a physical character, and to which his own methods have led him. By employing certain general principles, respecting powers and roots, and respecting differentials and integrals of Quaternions, he finds that for any system or set of diverging vectors, $\alpha, \beta, \gamma, \ldots \kappa, \lambda$, the continued product of the square roots of their successive quotients may be expressed under the following form:

$$\left(\frac{\alpha}{\beta}\right)^{\frac{1}{2}}\left(\frac{\beta}{\gamma}\right)^{\frac{1}{2}}\ldots\left(\frac{\kappa}{\lambda}\right)^{\frac{1}{2}}\left(\frac{\lambda}{\alpha}\right)^{\frac{1}{2}} = (\cos \pm U\alpha \sin)\frac{s}{2}; \qquad (75)$$

where s is a scalar which represents the *spherical excess* of the pyramidal angle formed by the diverging vectors; or the *spherical opening* of that pyramid; or the *area* of the spherical polygon, of which the corners are the points where the vectors $\alpha, \beta, \gamma, \ldots \kappa, \lambda$, meet the spheric surface described about their common origin with a radius equal to unity. And by combining this result with the general method stated to the Academy by the Author[*] in November, 1844, for connecting quaternions with rotations, it is easy to conclude that if a solid body be made to revolve in succession round any number of different axes, all passing through one fixed point, so as first to bring a line α into coincidence with a line β, by a rotation round an axis perpendicular to both; secondly, to bring the line β into coincidence with a line γ, by turning round an axis to which both β and γ are perpendicular; and so on, till, after bringing the line κ to the position λ, the line λ is brought to the position α with which we began; then *the body will be brought, by this succession of rotations, into the same final position as if it had revolved round the first or last position of the line* α, *as an axis, through an angle of finite rotation, which has the same numerical measure as the spherical opening of the pyramid* $(\alpha, \beta, \gamma, \ldots \kappa, \lambda)$ *whose edges are the successive positions of that line.*

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[*] The same connexion between the Author's principles, and geometrical or algebraical questions, respecting the rotation of a solid body, or respecting the closely connected subject of the transformation of rectangular coordinates, was independently perceived by Mr. Cayley; who inserted a communication on the subject in the Philosophical Magazine for February, 1845, under the title, "Results respecting Quaternions." It is impossible for the Author, in the present sketch, to do more than refer here to Mr. Cayley's important researches respecting the Dynamics of Rotation, published in the Cambridge and Dublin Mathematical Journal. An account of the speculations and results of the late Professor Mac Cullagh on this subject may be found in part viii. of the Proceedings of the Royal Irish Academy; and a summary of the views and discoveries of Poinsot has been given by that able author in his very interesting tract, entitled, *Théorie Nouvelle de la Rotation des Corps*, Paris, 1834.

JANUARY 24TH, 1848.

REV. HUMPHREY LLOYD, D. D., PRESIDENT, in the Chair.

THE Rev. Richard Mac Donnell, D. D., having been called to the Chair, the President communicated an account of a method of determining the total intensity of the earth's magnetic force in absolute measure, applicable in the high magnetic latitudes.

The ordinary process for the determination of the earth's magnetic force, it is well known, consists in observing the time of vibration of a freely-suspended horizontal magnet, whose moment of inertia is known; and then employing the same magnet to deflect another, similarly suspended, and observing the angle of deflection at a given distance. From these two observations the *horizontal* component of the earth's magnetic force is deduced; and the *total* force is thence inferred, by multiplying by the secant of the inclination.

This method is inapplicable in the high magnetic latitudes. The relative error of the force, arising from a given error of inclination, varies as the tangent of that angle; and, where the inclination approaches 90°, it becomes so great as to render the result valueless. I was induced to consider the means of supplying this defect, upon the occasion of the expedition of Sir John Franklin to the Polar Sea in 1845; and I have been recently led to re-examine the problem, on account of the two Arctic expeditions, under Sir James Ross and Sir John Richardson, which are now in course of preparation.

The object to be attained is to determine the total force *directly*, without the intervention of its horizontal component. The ordinary inclinometer will serve for this purpose. The *statical* method, in which the position of the dipping needle is observed under the combined action of magnetism and gravity,* will enable us to determine the product of the earth's total magnetic force into the moment of free magnetism of the needle; and the ratio of the same quantities may be obtained (as in the case of the horizontal component) by removing this needle, and employing it to deflect another substituted in its place.

Let us suppose, for generality, that the needle moves in any vertical plane, inclined to the plane of the magnetic meridian by the angle a; and let R denote the earth's magnetic force, X and Y its horizontal and vertical components, and m the magnetic moment of the needle. Then, the effective magnetic forces are $mX \cos a$, mY; and their moment to turn the needle is

$$m(Y \cos \eta - X \cos a \sin \eta);$$

in which η denotes the actual inclination of the needle to the horizon. This moment is opposed by that of the weight. Let this be applied in the manner adopted by Mr. Fox, namely, at the circumference of a light pulley, whose centre is on the axis of the cylindrical axle. Its moment is in this case independent of the position of the needle, and is equal to the weight, W, multiplied by the radius, r, of the pulley at whose circumference it is applied. Accordingly, the equation of equilibrium is

$$m(Y \cos \eta - X \sin \eta \cos a) = Wr. \qquad (1)$$

There are two cases which deserve consideration,—namely, that in which the plane of motion of the needle coincides with the magnetic meridian, and that in which it is perpendicular to it. In the former case $a = 0$; and substituting for X and Y

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[*] The principle of this method appears to have been first suggested by Mr. Christie, for the *relative* determination of the intensity; and it has been since applied, under different modifications, by Mr. Fox and myself, to the same purpose. Mr. Fox's mode of applying it, although not the simplest in practice, is undoubtedly the best.

their values, $R\cos\theta$ and $R\sin\theta$ (θ being the inclination), the preceding equation becomes

$$mR\sin(\theta - \eta) = Wr; \tag{2}$$

from which we obtain mR, the product of the earth's magnetic force into the moment of free magnetism of the needle, when W and r are known, and the angles θ and η given by observation. In the latter case, $a = 90°$, and (1) becomes

$$mY\cos\eta = Wr; \tag{3}$$

which gives the similar product in the case of the vertical component of the force.

Now let the needle be removed, and applied to deflect another which is substituted in its place; and let the deflecting needle be placed so that its axis passes through the centre of the supported needle, and is perpendicular to its axis. Then the moment of its force to turn the needle is $mm'U$, in which m' is the moment of free magnetism of the second needle, and U a function of D, the distance of the centres of the two needles, of the form

$$U = \frac{2}{D^3}\left(1 + \frac{p}{D^2} + \frac{q}{D^4}\right).$$

The moment of the earth's magnetic force, opposed to this, is of the form already assigned, in which we have only to substitute m' and η' for m and η. Hence the equation of equilibrium is

$$Y\cos\eta' - X\sin\eta'\cos a = mU. \tag{4}$$

When the plane of motion of the needle coincides with the magnetic meridian, or $a = 0$, this becomes

$$R\sin(\theta - \eta') = mU; \tag{5}$$

which gives the ratio of the earth's magnetic force to the magnetic moment of the needle, when U is known, and the angles θ and η' given by observation. The coefficients p and q, in the value of U, may be obtained (as in the ordinary method) by observing the angles of deflection, $\theta - \eta'$, at different distances; it is probable, however, that their values may be inferred, *à priori*, from the lengths of the needles, with as much accuracy as is attainable in observations of this nature. When the plane of motion is perpendicular to the magnetic meridian, or $a = 90°$,

$$Y \cos \eta' = m U; \tag{6}$$

which gives, in like manner, the ratio of the vertical component to the magnetic moment of the needle.

The total force is determined, *absolutely*, by means of the two observations in the plane of the meridian: for, multiplying the equations (2) (5), m disappears, and we have

$$R^2 = \frac{W r U}{\sin u \sin u'}, \tag{7}$$

in which the angles of deflection, $\theta - \eta$, $\theta - \eta'$, are denoted for abridgement by u and u'. Again, dividing the former of these equations by the latter,

$$m^2 = \frac{W r}{U} \cdot \frac{\sin u'}{\sin u}. \tag{8}$$

The equations (3) (6) furnish, in like manner, a similar value of the vertical component of the force.

In order to determine the probable error in the resulting value of the force, arising from the errors of the observed angles, u and u', we have to observe that the moveable needle is acted on, in each case, by two forces, one of which is the moment of the earth's magnetic force, $mR \sin u$, while the other is constant. Hence, in any position, the directive force is

$$F = mR \sin u - G.$$

Let u_0 denote the value of u, corresponding to $F = 0$, or to the case of equilibrium; then $mR \sin u_0 = G$, and

$$F = mR(\sin u - \sin u_0).$$

Let $u = u_0 + \Delta u_0$, Δu_0 being a small angle,—or, in other words, let the needle be displaced by a small amount from the position of equilibrium,—and let the force brought into play by the displacement be just balanced by friction; then

$$f = mR \cos u_0 \Delta u_0 ,$$

f denoting the moment of friction. Now, this being constant for a given instrument, $\cos u_0 \Delta u_0$ is so likewise: and we have

$$\cos u_0 \Delta u_0 = \varepsilon,$$

ε denoting the value of Δu_0 corresponding to $u_0 = 0$, or the limit of the error due to friction in the natural position of the needle, under the influence of the earth's magnetic force alone.

To find the error in the value of R, corresponding to Δu_0, we have only to differentiate the equation of equilibrium with respect to R and u_0, and we have

$$\Delta R \sin u_0 + R \cos u_0 \, \Delta u_0 = 0 ;$$

and, substituting for $\cos u_0 \, \Delta u_0$, its value above given,

$$\frac{\Delta R}{R} = \frac{-\varepsilon}{\sin u_0}.$$

We see, then, that the relative error in the value of the force resulting from friction, in either part of the process, is inversely as the sine of the angle of deflection; and that it is, therefore, requisite for accuracy that these angles should be considerable. The angle of deflection may obviously be as large as we please in the first part of the process, where the deflection is caused by a weight; but, in the second, a large deflection can only be produced by a massive magnet, and such a magnet cannot be employed in the first part without impairing the accuracy of the result by the increased friction. The conditions of accuracy required in the two parts of the process are, therefore, incompatible.

We evade this difficulty by employing the inclinometer for one only (namely, the second) of the two observations, The plane of the instrument being made to coincide with the magnetic meridian, and facing the East, the deflecting magnet is to be fixed on its support at a given distance, with its north pole *towards* the needle; and the angles of position of the deflected needle, a_1 and a_2,—with its north pole towards the north, and towards the south, respectively,—are to be observed. The deflecting magnet is then to be reversed on its supports, so as to have its north pole turned *from* the needle, its distance being unchanged. Then a_3 and a_4 being the corresponding angles of position, the magnetic inclination is

$$\theta = \tfrac{1}{4}(a_1 + a_2 - a_3 + a_4);$$

and the angle of deflection is

$$u = \tfrac{1}{4}(a_1 - a_2 + a_3 - a_4).$$

The observations are to be repeated, with the face of the instrument towards the West, and will give new values of θ and u, which are be combined with the former. We have only to observe that, in this latter case, the arithmetical mean of the four observed angles is the *supplement of the inclination*, instead of the inclination itself.

Dr. Allman exhibited and described a singular implement discovered in an ancient copper mine in the parish of Skull, Co. Cork. It consists of a tube formed of yew timber, gradually increasing in diameter towards one end, and bent in the manner of a siphon at an angle of about 80°, the point of flexure being nearer to the narrower end. A slit nearly half an inch in width extends for about the middle third of the concave side through the thickness of the walls, and at the narrower end are indications of wear, as if the implement had been here fitted into a collar or tube of greater diameter. It presents the following dimensions:

Length of the longer leg, ...	17	inches.
,, ,, shorter do.	13	,,
Diameter at small end, ...	1½	,,
,, ,, large end, ...	2¼	,,

Another implement, constructed also of yew timber, and evidently related to that just described, was found along with the latter, and also exhibited by Dr. Allman. It resembles a funnel formed of two cylinders of different diameters, the wider constituting the mouth, and the narrower the neck, the whole being scooped out of a single piece. The neck of the funnel fits accurately into the wider end of the siphon. The following are the measurements:

Length of wider cylinder, ...	2¾	inches.
,, narrower ,, ...	2	,,
Diameter of wider cylinder, ...	2½	,,
,, narrower ,, ...	1½	,,

The mine in which the implements just described were found is one of several vertical cuttings recently discovered near Ballydehob, in the parish of Skull, and apparently of very great antiquity. The cuttings, when discovered, were filled to the surface with the rubbish of the ancient workings, and when this was removed there were found, lying at the bottom, the subjects of the present communication, along with a great number of rolled stones, almost all of which exhibited marks of attrition, as if they had been used instead of hammers. A beam of oak timber, about twenty feet in length, and notched along the sides, in such a way as to suggest its use as an ancient ladder, was also found in the same place.

Some idea of the antiquity of these singular mining operations may be formed from the fact of some of the old rubbish being now found near the mouth of the cuttings, with a covering of more than two feet of apparently naturally formed peat.

The implements exhibited are the property of J. W. Clerke, Esq., of Skibbereen, to whom Dr. Allman is indebted for the opportunity of thus laying them before the Academy.

The Rev. Dr. Todd read an original and hitherto unpublished letter, relating to Wood's coinage, by Dr. William King, Archbishop of Dublin. The letter is an autograph, and is preserved in the Library of Trinity College, Dublin. It has, unfortunately, received some injury, by which the first line of each page has been lost. The date is missing, except the word *July*, which is still legible. But as the letter is addressed to Edward Hopkins, Esq., the Private Secretary of the Duke of Grafton, and as it was evidently written before Wood's name became known as the patentee of the new coinage, we must assign it to the year 1722; for the Duke of Grafton came over as Lord Lieutenant in August, 1721, and Wood's patent was issued in the beginning of 1723.

The letter is as follows:

"*. . . . July . . . .*

"SIR,—I gave his Grace my L L^{t} the trouble of a letter of the tenth instance relating to a report we have here of a patent for coining brass money for this Kingdom; the first notice I had of it was from the public prints and w^{n} I went abroad found it in every body's mouth, with great indications of surprise & dissatisfaction. Since y^{t} time I have had occasion to discourse the most considerable, y^{e} most knowing and best affected to his Majesties government in this city about it, most of w^{m} seem perswaded y^{t} a thing of this consequence & which as it is rep^{r}sented is in their opinion monstrous, for so they express themselves, cannot be attempted at all. I gathered up their sense as well as [I] cou'd and think my self obliged to communicate it to you, y^{t} if you think fit you may lay it before his Grace the L^{d} L^{t}.

"1st. therefore they say, that this is an after game of the enemies of the Kingdom, who endeavoured to put on us paper instead of silver by a Bank, & failing to cheat us y^t way, they now wou'd impose brass on us which in the event will be equaly pernicious and rather more, for there was some colour of a security for exchanging those bank bills for money, but there can be none for this; there was a possibility of preventing counterfeting in y^t case, but there can be none here.

2^{dly}. They allege y^t there is no need of brass money for change, since we still have enuf for that purpose, & to have more is so much loss to y^e kingdom.

"3^{rdly}. They suspect this coinage will be granted to some favourite who will set it out to underlings and they will not fail to make the best of it, and regard only their own profit, without any consideration to w^t the kingdom may . . . . . by it . . . . patent granted formerly, if I remembr right to the Earl of Arran to coin 20^m pounds in half pence & a clause in it, y^t none shoud be obliged to take above a certain sum in y^m. This was immediately sold to some who made their fortune by it, they were obliged to change these half pence w^n required, but easily evaded the obligation, and 'twas thus. The stamps used in coining I think are called dice, and these soon wear out and new ones are substituted in their room; they contrived to have the 2^d sett somew^t different from the first, & y^n, after awhile, w^n required to change any sum they only allowed those of the first stamp to be genuine, and alleged all the rest to be counterfeit, and who could prove the contrary; but suppose the patent obliged the grantee to change all, w^t way is there to come at him, the lowsers are at a loss how to do it, or in whose name the suit must be brought, and it is manifest it were better for any private man to lose an 100^{lb} y^n enter into such a law suit.

"4^{thly}. Tis observed y^t the Patentees did not confine y^{m}selves to any sum, tho' their patent obliged y^m, but coined on till the collectors of the Kings revenue were forced to send up their money in barrels of half pence, and there was hardly a tinker or blacksmith but coined as fast as these and the kingdom is still well stored with these w^{ch} pass under the name of Raps; now such counterfeters being become much more dexterous and more intent on their private gain y^{n} they were y^{n}, if a new Coinage be permitted it will be impossible to prevent over whelming us with such false half pieces, especially if we consider the artifices and intentness on gain of some of our neighbours, nations, who in all probability will . . . . of any coin.

" 5^{thly}. It is not easy to counterfeit old coin; for tho they can give the same stamp, yet they can hardly give the old look, hence it is y^{t} every new coinage gives great oportunity to counterfiting, as we experienced in the time of King William, when all the specieses were new; a swarm of false coiners then arose, and great numbers were hanged, whereas now the practice is much abated; we must therefore expect, y^{t} on coining new brass pieces every town will have them set up for y^{t} mysterie. I know not w^{t} may be the penalty by law of counterfeiting such coin, but I doubt much, w^{t}ever the penaltie be, whether juries will be prevailed on to find the forger guilty, perhaps they will believe y^{t} the poor man had as good a right and as great a necessity on him to cheat y^{e} publick as the patentee.

" 6^{thly}. Mony of this sort will soon be at a great discount, as it happened to the brass money in King James time; and y^{n} if a landlord be p^{d} any considerable sum in it, he will be obliged to pay considerably to get it turned into silver, his receiver will be sure to buy as many half pence as he can and keep the gold and silver to himself, and pay his master with brass, the gain will be his, and the loss his masters, and this will be hardest on landlords who live remote from their estates, especially such as live in England.

" 7^{thly}. All matters relating to coin, such as raising or lowering it, determining w^{t} species shall pass, & at w^{t} rate, has ever bin done by the L^{d} L^{t} & Council here, as may be seen by the many proclamations to y^{t} purpose, w^{re}by it appears y^{t} our

Kings and Queens have always on such occasions thought fit to consult y^{m}. If this do not take y^{e} same course it will be looked on as a slight by my L^{d} L^{t}, lessen him greatly in the opinin of the people, and cause a disaffection in many best affected now, to find themselves slighted.

“ 8^{thly}. It is reasonable and must be expected y^{t} people will pay their debts in such coin as they are obliged to receive theirs; in if therefore the people of Ireland receive their rents and revenues in brass, their creditors must expect no other; now we commonly send about 400^{m} pounds into England every year in pensions, salarys, rents, &c. Suppose y^{n} a tenant pays a landlord rent here in brass, w^{t} shall the receiver do with it? to be sure no Banker will change it for him, and y^{n} must not he send it in specie barrelled up by long sea, and can he expect it otherwise? the case will be the same in pensions and all other appointments if its . . . . . . there may . . . . . . in the patent, y^{t} none shall be obliged to receive above a certain quantity in brass; it ought to be considered y^{t} most of his Majestie's revenu is paid in small sums, most of the fees in offices and most of the rents from terreten^{ts}, and w^{n} these come to the hands of Collectors and receivers they must take y^{m}, and w^{n} put together they will make great sums, and y^{n} can the persons for w^{m} they are rec^{d} refuse y^{m}? I remember w^{n} the half pennys were coined here before the Revolution, many firkins of them were sent to y^{e} treasury by the Collectors and great complaints were made of it, and it put a great damp on all business & trade.

“ 9^{thly}. 'Tis certain the Protestants of Ireland were most zealously attached to his Majestie & government, I believe you are sinsibly [*sic*] how much they are soured of late by the treatment with w^{ch} they have met. I am afraid this patent if it pass, as it will compleat their ruin, for so they reckon, so it may put an end to their good affections, & in as much as it is supposed y^{t} this patent is granted to gratify some private persons, sure it ought to be considered whether it be good policy to sacrifice a whole kingdom to their particular profit.

"A great many other things are said w^h^ are not fit for me to write, I only mention w^t^ I find universally insisted on. I do not expect to do myself any service by freedom, I wish it may serve his Majestie's interest and the public, as it is I am sure intended, w^t^ever happen to

"S^r^

"Your

* * * * * *

"*Edward Hopkins Esq.*"

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February 14th, 1848.

Rev. HUMPHREY LLOYD, D. D., President, in the Chair.

The Very Rev. J. J. Taylor, D. D.; Rev. Matthew Newport, D. D.; Frederick V. Clarendon, Charles Ottley, O'Neale Segrave, Matthew E. Talbot, and Charles Tarrant, Esqrs., were elected members of the Academy.

The Rev. Charles Graves read a paper on a general method of deciphering secret alphabetic writings.

Mr. Graves commenced by stating that he had been led to discuss the general question of deciphering, in consequence of his having undertaken, some time ago, an examination of the singular inscriptions in the Ogham character which are to be found in this country. Irish scholars and antiquaries, to whose opinions great deference is due, having pronounced that no satisfactory readings of these inscriptions had been obtained by means of the key given in the Book of Ballymote and other Irish manuscripts professing to treat of the Ogham character, Mr. Graves abandoned the attempt to draw from these sources the means of deciphering it, and applied himself to the task of constructing a key from the monuments themselves. He was furnished with materials for doing this by the kindness of Captain Larcom and Mr. Petrie, the former of whom placed at his disposal all the drawings of Ogham inscriptions collected by the draughtsmen employed on the Ordnance Survey of Ireland; whilst the latter furnished him with numerous and accurate tracings of inscriptions taken from his own sketch-books. And here arose a question as to the best mode of employing these materials. The common methods of deciphering, which assume that the writing to be deciphered is divided into words, were at once found to be inapplicable to the Ogham character, the inscriptions in which are written continuously. In seeking to frame a method applicable in this and similar cases, Mr. Graves conceived the one which he then proceeded to describe.

This method rests upon the following principle: *that in any given language, or group of cognate languages, there is a preference for particular sounds, and particular sequences of sounds.*

In order to determine what are the favourite sounds or sequences in a language, we must analyze considerable portions of it in such a way as to exhibit its tendencies to repeat and combine the several letters of its alphabet. This end is arrived at by the construction of a table, which shows how often, on an average, each letter is followed by each of the remaining ones, in a passage of some determined length; as, for instance, a passage consisting of ten thousand letters. With such a table at hand, it is not difficult to assign their proper powers to the secret characters or ciphers in which a document in that language is written. We have merely to tabulate the sequences of the ciphers; and, by comparing their tendencies to repetition and combination with those of the known letters, we readily arrive at a knowledge of their respective powers. It is here assumed that the document to be deciphered is of a reasonable length. This condition is indispensable, inasmuch as the distribution of the letters in a passage consisting only of a few words might differ widely from the average distribution. In order to be able to decipher an article written in a language of the nature of which he is not informed *a priori*, the decipherer ought to be provided with tables formed by the analysis of many languages of different kinds, with which the table of the cipher might be compared successively.

A collection of sequence tables would be valuable, not merely for the purpose of deciphering, but also in connexion with philology. They would exhibit to the eye affinities and characteristic differences of cognate languages: they would manifest the changes which particular languages undergo in the course of time: they would, moreover, indicate general principles of euphony, prevailing amongst all languages, and founded on the very nature of our organs of speech and hearing.

It is easy to see that, by reference to principles of this kind, considerable progress might be made towards the deciphering of purely alphabetic writings in a language wholly unknown. A tabular analysis will, in the first instance, discover vowels by their greater readiness to combine with other letters either preceding or following them; next, amongst the consonants, the liquids, particularly *r*, will in general be found to combine with the rest most freely; and, lastly, the letters of the same organ will be found to form a group which enter *similarly* into combination.

Mr. Graves suggested that this method of tabulating might be employed with advantage in the case of the cuneiform writings. Admitting that one or two kinds of this character had been deciphered, and found to be phonetic, we might tabulate the deciphered inscriptions, and compare the tables so formed with one founded on an analysis of inscriptions in a third and different cuneiform character. If this latter were phonetic, and its language cognate with those of the deciphered kinds, we might expect to find the three tables possessing points of marked similarity. Nay, more, it seems that we might thus ascertain whether any given writing, of which there existed considerable remains, were phonetic or ideagraphic. In the former case, it is evident that the distribution of characters in any two passages of equal and considerable length would be very similar; in the latter, we could not count upon so great uniformity, seeing that the connexion of ideas is so much less regular than the sequence of sounds.

In proof of the actual efficiency of his method Mr. Graves exhibited two tables, one of which was founded upon an analysis of a small number of Runic inscriptions, the other being made from a short passage of Icelandic of the thirteenth century. A cursory inspection of these tables would be sufficient to enable a decipherer to assign their proper powers to the Runic letters, supposing that their values had not been otherwise known. Mr. Graves also exhibited tables formed from the analysis of passages in the Irish language, contained in the Book of Armagh, and written, as he believes, according to the orthography of the seventh century. These were the tables employed by him in determining the powers of the Ogham characters; but he reserved the statement of the results arrived at in that research for a communication which he hoped very soon to make to the Academy.

FEBRUARY 28TH, 1848.

REV. HUMPHREY LLOYD, D. D., PRESIDENT, in the Chair.

Sir William Betham read the following letter from Mr. Cooke, of Parsonstown, relative to the coins exhibited by him to the Academy, on the 13th December last:[*]

"*Parsonstown*,
"*26th February*, 1848.

"DEAR SIR WILLIAM,—My son, who came from Dublin yesterday, informs me he did not deliver a letter I sent to him for you about a month ago. It is not of any great importance, but still you probably will feel an interest in a portion of its contents, in reference to the Etruscan coins I lent you.

"Since I had the pleasure of seeing you I was speaking to the person from whom I purchased these coins, and he offered to make affidavit that they were found in the county Tipperary, in some sort of earthen vase, which was broken, and did not reach him. He would not then tell me the precise locality, as he said he was under a solemn engagement not to disclose it, but he promised to obtain liberty to do so by the next time I should see him. I can only add, that *I believe he is convinced of the truth of his statement*, for, exclusive of my thinking him an honest man, he could not have any object in telling a falsehood on the subject, the coins being mine before I asked anything about where he got them. I thought, in my hurried interview with him at the time I purchased the coins, that he named the neighbourhood of Tullamore, but in that I find I was mistaken.

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[*] See Proceedings of the Royal Irish Academy, vol. iv. p. 29.

"I gave my son directions to show you two other coins of the same set, which you possibly will also reckon Etruscan.

"I am, dear Sir William,
"Your faithful Servant,
"THOMAS L. COOKE."

The following notice was communicated by Sir William Rowan Hamilton, of a Paper "on the Application of Quaternions to the Determination of the Distance of any recently discovered Comet or Planet from the Earth."

This celebrated problem is treated in this paper by means of the formulæ which were communicated to the Academy by the author, in July, 1845. The chief step consists in a very easy deduction, from those formulæ, of the equation:

$$\frac{a}{c}\left(\frac{M}{a^3}-\frac{M}{b^3}\right)=\frac{S.\gamma\gamma'\gamma''}{S.\gamma\gamma'\alpha};$$

where c is the sought distance of the comet (or planet) from the earth; M is the mass of the sun, and a and b are the distances of earth and comet from that body; α is the heliocentric vector-unit of the earth, and γ is the geocentric vector-unit of the comet; while γ', γ'' are the first and second differential coefficients of γ, taken with respect to the time, and determined, along with γ itself, from three successive observations: and S is the characteristic of the operation of taking the scalar part of a quaternion. The second member of the equation admits of being geometrically interpreted as a ratio of two pyramids, and can in various ways be transformed by the rules of the calculus of quaternions.

Mr. Donovan exhibited a table gas lamp of his invention, which generates its own gas, and made the following statement relative to it:

" Previously to describing my inventions, for some of which I obtained patents for the three kingdoms and colonies, it will be necessary to make some observations on the nature of those substances which are concerned in the production of economical light.

" Every one knows that, although hydrogen is a chief combustible element in all those flames which are used for the purpose of illumination, its own flame, when the gas is perfectly pure, shows no light. In order to render it luminous we have only to diffuse through it a small quantity of one or other of the different forms of carbon or charcoal in a state of very minute division. All our ordinary lights are derived from combinations of hydrogen and carbon; such are coal gas, oil gas, resin gas, coal naphtha; or from combinations of hydrogen, carbon, and oxygen, as oil, tallow, wax, spermaceti, stearine of various kinds.

" If the ratio of carbon to hydrogen be too small, the light emitted from the combustible in burning will be pale and feeble; if the ratio of carbon be too large, the flame will be yellow, or even brown and smoky. It is to the due adaptation of the ratio of these two elements to the supply of oxygen, whether contained in the combustible or in the air, that we owe the production of the many brilliant lights which we possess.

" But the carbon and hydrogen need not be in that state of combination in which we procure them. A hydrogen flame may be rendered intensely luminous by the artificial supply of carbonaceous matter; and a flame which is too pale and feeble, such as that of hydrogen, bad coal gas, or of the oil or stearine from the cocoa-nut, may be enriched to the greatest intensity by merely presenting carbon in a proper state. Carbon in such a state exists in all the volatile hydro-carbons, as mineral naphtha, naphthaline, naphtha from coal tar, from oil, from resin, or from Indian rubber; it exists also in essential oils, and in spirit of turpentine or of resin, or of tar.

" It was upon a knowledge of these facts that I founded the inventions for which I obtained patents. My first efforts were directed to the diffusion of the vapour of coal naphtha through hydrogen gas; and to effect this object with economy and brilliancy of the resulting light, I contrived a variety of instruments.

" In the specification of my patents I minutely described some of these; a brief account of one will here suffice, as the details now constitute one of the public records. Into this instrument, which is in the form of a lamp, a stream of hydrogen is passed, and dispersed by a tube having many small holes into a small cylinder, also pierced with holes, and round which a piece of iron wire-gauze is rolled. This wire-gauze roll is continually kept wetted, either with one of the less volatile kinds of coal naphtha, or with naphtha obtained from resin or from Indian rubber, or with spirit of turpentine, or fine spirit of tar, or other volatile hydro-carbon. The hydrogen passes out through the holes of the burner of the lamp, and, being kindled, generates much heat, which, being quickly transmitted downwards to the wire-gauze, heats the volatile hydro-carbon with which it is constantly impregnated, and converts it into vapour. The vapour mixes with the hydrogen, and the mixture is now much of the same nature as coal gas, or oil gas, or resin gas; it burns with great brilliancy, provided that the parts of the lamp bear a proper proportion to each other.

" The office of the roll of iron gauze is to raise the hydrocarbon by capillary attraction through its meshes and convolutions, and thus to present the hydro-carbon on extensive surfaces to the solvent power of the hydrogen which continually passes through.

" In my early experiments I had found that the less volatile hydro-carbons did not diffuse their vapour through hydrogen at ordinary temperatures, and hence it was necessary to maintain an elevated degree by the application of foreign heat. It was an important improvement to contrive the apparatus in such a manner that the hydro-carbon should be constantly maintained at an adequate temperature by the proximity of its own combustion. This was at last effected by very much shortening the burner and gas-ways, and connecting the brass tube which held the wire-gauze with the burner, so that the heat of the flame was transmitted directly downwards, by conduction, to the wire-gauze and hydro-carbon.

" Hydrogen, as obtained by the processes of the laboratory, is exceedingly expensive; it therefore became necessary to ascertain whether I might substitute for it that very light carbureted hydrogen which is procured by passing the steam of water over charcoal or coke, maintained at a bright red heat in an iron retort. This gas contains so little carbon, that, for practical purposes, it may be considered as hydrogen; and it was essential to know whether, when used in the above-mentioned manner, it would create a sufficiency of heat to volatilize the hydro-carbon.

" In order to ascertain this and other important particulars, I caused an iron gas retort of the ordinary kind, with a well ground mouth-piece, to be built into a furnace erected for that purpose. The retort was capable of containing two pounds of Newcastle coke; it was furnished with a tube and stopcock at one end for the admission of steam : and a tube at the other end for carrying off the gas generated by the decomposition of the water into a gasometer containing milk of lime.

" When the retort was maintained at a bright red heat, and the steam let on, gas was generated in such torrents that at one time I feared some untoward result. By calculation from this experiment I found that to furnish 1000 cubic feet of gas 16·8 avoirdupois pounds of coke should disappear. The interior of the iron retort had been previously protoxidized, to prevent, as much as possible, its contributing to the production of hydrogen. But I found that, although the scale of protoxide is exceedingly hard, it does not protect the interior of the iron; the process of destruction is slow but certain. Earthen gas retorts, such as were patented several years since by Mr. Grafton, would perhaps answer better.

"On making a trial of this, which has been called water gas, I found that, notwithstanding the presence of much carbonic oxide, it gave off quite a sufficiency of heat, when burned in my different lamps, to volatilize the hydro-carbon, and to afford a brilliant light: by itself it burns blue.

"The various volatile combustible liquids already mentioned are applicable to the foregoing purposes with different degrees of efficacy. Those that require high temperatures for their volatilization are the fittest, because the source of heat is so near the wire-gauze that the vaporization easily takes place.

"But there are hydro-carbons which, being volatilized at the ordinary temperature of the air, afford much more manageable means of rendering hydrogen gas luminous in burning. Of these, by far the most convenient and economical are the finer kinds of coal naphtha. It is obtained by the distillation of coal tar, and is procurable in various degrees of purity in commerce. Coal tar is an article of very small price, and when deprived of its naphtha, instead of being depreciated in value, it is enhanced. By several rectifications the naphtha becomes pure and colourless, and very volatile. Its quality varies materially according to the coal used at the gas works from which the tar was obtained. The greater the specific gravity, provided it is pure, the greater is its volatility. The purest and heaviest naphtha that I have been ever able to obtain from Newcastle coal tar, was S. G. 0·888: this was the result of repeated rectifications, the first products only, in every case, being retained. This naphtha began to boil at 166°, but boiled rapidly at 172°. The purest and heaviest naphtha, from Scotch Parrot coal tar, that I could procure by any number of rectifications, was S. G. 0·862°; it began to boil at 183°, and boiled rapidly at 189°. None of these naphthas have a fixed boiling-point. In all cases the heaviest and most volatile portions come over first in distillation, and are the most valuable for the purposes here described. No dependence is to be placed on high specific gravity as a test of fitness: the naphtha may be heavy on account of the presence of tar and naphthaline, and in this state it will not answer the purpose. When the naphtha is colourless, heavy, and vaporizable from a flat open vessel, without leaving any residuum or stain, it is of the best quality.

"During the destructive distillation of common resin, a naphtha is obtained which, by proper rectification, becomes as pale as water, and succeeds admirably for the purposes here described. Indian rubber affords a naphtha of s. g. 0·820, or even 0·680; in which last state it boils at 98°, and answers perfectly.

"The ratio of hydro-carbon necessary for rendering a certain quantity of water gas luminous in burning, will depend on the nature of the former. On this subject I made many experiments. In one of them I found that two equal burners, one supplied from a gasometer containing coal gas, the other from a gasometer containing water gas, which was naphthalized with Newcastle coal tar naphtha before it reached the burner, afforded flames which in equal times emitted equal light when the naphtha was consumed at the rate of one imperial gallon dissolved in 1000 cubic feet of water gas. It was also found that the consumption of coal gas was the same as that of water gas in equal times, the latter having the addition already mentioned; and although the light in each case was equal, as evidenced by Rumford's photometer, the water gas flame was but half the volume of that from coal gas; and therefore the intensity or illuminating power of the former was double. This comparison only holds when the rate of consumption is five cubic feet per hour; when less, the light from a naphthalized water gas flame is more than double the light of an equal volume of coal gas flame. If it be desirable that the illuminating power of naphthalized water gas shall be at its *maximum*, the ratio must be ten and a half imperial pints to 1000 cubic feet of gas. Any higher ratio only impairs the light. When spirit of turpentine is used with water gas, the ratio should be one imperial gallon to 1000 cubic feet.

"The more pure and volatile kinds of naphtha are extremely valuable, from the circumstance of their being easily soluble in hydrogen, or in water gas, at ordinary temperatures. We have only to present extensive surfaces of the naphtha to a current of water gas; the result will be that the gas will dissolve a quantity of naphtha, and will hold it dissolved even at the temperature of 32°. The mixture of gas and naphtha vapour may be transmitted through tubes in the manner of ordinary coal gas, and burned in the usual way; its light is white and beautiful. I have described an instrument for producing this gas in the specification of my patent for Scotland.

"I ascertained that when carbonic oxide is naphthalized, its combustion affords a light of brilliant whiteness, although its natural colour in burning is blue.

"Since it was thus proved that hydrogen containing a very small quantity of carbon was capable of dissolving naphtha, it became a question whether that variety of the same combination called coal gas would exert a similar agency, and thus be rendered capable of burning with increased brilliancy. I therefore arranged two common gas-burners for comparison, one being supplied with mere coal gas, the other with coal gas which was made to pass through an apparatus properly constructed for naphthalizing it. It required but little observation to decide that the naphthalized flame was much more brilliant and dense.

"When this trial was made with a gasometer attached to each burner, and an apparatus for determining the quantity consumed, it appeared, after a few hours' trial, that to produce equality of light from both burners, 5·36 cubic feet of coal gas were equal to three cubic feet of naphthalized coal gas which contained 200 grains of naphtha (s. G. 0·872). Such were the quantities burned per hour. Hence 1000 cubic feet of coal gas would require 6·511 imperial pints of such naphtha dissolved in it, in order to give a light which, in illuminating power, would be to that of mere coal gas as 25 to 14.

"I ascertained that the gas which is generated so abundantly during the destructive distillation of wood succeeds perfectly for the purpose of illumination, when enriched with the vapour of naphtha or spirit of turpentine. During this distillation two kinds of volatile spirit are produced; one of them is well known in commerce, it burns with a pale flame like alcohol; the other burns with a smoky yellow flame, highly luminous. The latter, when purified, answers as well as coal naphtha for the purposes here described. Some kinds of wood afford so much as one-third of their weight of inflammable gas. It is obvious how deserving these facts are of consideration in countries where wood is abundant and coal scarce.

"It is, no doubt, in the recollection of many, that some years since attempts were made to introduce gas condensed in iron cylinders into public use, in Dublin and London; and portable gas companies were formed for the purpose of carrying that object into effect. I need not now enter into the nature of this project or the cause of its failure. I shall only observe that, by simple methods, founded on the principles already described, it would have been very easy to insure success. I have produced beautiful portable gas-lights, which exceeded all others in steadiness and lustre, by introducing bits of zinc, with a little dilute sulphuric acid, into a copper cylinder, in all respects made like those of iron employed by the portable gas companies. Hydrogen was not only generated, but, as there was no escape, it became highly condensed, even to thirty atmospheres. By screwing on the valve a contrivance somewhat resembling the instruments described in the specifications of my patents, containing naphtha, a flame of unusual steadiness and beauty was produced.

"But there is one modification of the invention which far surpasses all the rest in the facility with which it can be carried into profitable effect, and the universality of its application. I shall proceed to describe it.

"As soon as I ascertained that the vapour of naphtha so easily diffuses itself through various gases, it became a question would naphtha comport itself similarly with atmospheric air, and if so, might not naphthalized common air, notwithstanding the presence of so much azote, afford a flame capable of affording a strong illumination? Experiment proved that the suspicion was well founded. I tried many methods. I found that a mixture of air and naphtha vapour, *in a certain ratio*, would burn with a very white and brilliant flame; that if the ratio of naphtha were too small, the flame was blue and illuminous, like that of carbonic oxide: and that if the ratio were too great, the light was yellow or brown and smoky. The difficulty was to contrive self-acting means adequate to the apportioning of a sufficient quantity, and no more, of naphtha vapour, to the atmospheric air. My first trials were made with a gasometer filled with common air, which air, being passed over extensive surfaces of naphtha, held absorbed in a roll of hempen canvas, instead of wire-gauze, and maintained at a certain degree of heat, dissolved a portion. The naphthalized air being forced through the holes of a burner, and kindled, afforded a blue flame which showed no light, for the naphtha was too far from the heat of the burner to be maintained at a sufficient temperature.

"I next procured an apparatus in which the burner communicated sufficient heat to the naphtha, and thus obtained a white light; but the jet arising from each hole in the burner was distinct, and the cylinder of flame, instead of being continuous, consisted of separate threads of light.

" The cause was obvious, and the defect was attempted to be remedied by procuring instruments in which the issue holes of the burner were very large and close together, and the gas-ways more than adequate to the supply. At length, by repeated trials, an apparatus was obtained which gave an excellent cylinder of dense flame, and the relative dimensions of the parts were thus determined.

" The advantages of this mode of lighting were obvious : an explosion could never take place ; and the tubes for conducting the air from the gasometer, instead of being metallic, might be of thick paper. I constructed lights with paper tubing which answered all purposes.

" But a sufficiently large gas-holder is expensive and inconvenient ; I therefore thought of adopting a double-bellows to my paper tubing. I procured double, triple, and quadruple bellows, most perfectly executed by an organ-builder, but could not obtain a blast which supplied the burners equably ; the lights rose high and sunk low with every stroke of the feeders ; and multiplying the feeders only multiplied the flickerings. At length the object was accomplished by causing a very small double bellows to discharge air into a reservoir bellows of comparatively large dimensions. When the two feeders were worked *at a certain rate*, and then only, the stream of air was equable, and the gas flames did not flicker. In order to insure this certain rate of action to the feeders, as well as to cause the apparatus to be self-acting, a piece of wheel-work machinery became necessary ; and I soon succeeded in adapting a train of wheels, which, being actuated by a weight and regulated by a fly, worked a crank that gave the exact motion required for the bellows. This train supplied the lights for several hours, and, when run down, could be wound up without extinguishing the lights, as it was furnished with a maintaining power.

" Conceiving that the perfection of the invention would be to embody it in the form of a table lamp, which should be as portable as any other, I directed my attention to this object. Finding that it was not practicable to enable so small a double bellows to sustain incessant working without being soon worn out, I discarded that plan; and, recollecting the centrifugal bellows as improved by Papin, in which fans revolving eccentrically in a circular tympanum, with a large opening in its centre, were sufficient to create a current of air, I had several such made in succession, and at length ascertained the smallest that would answer the purpose. Papin's construction failed, but by some alterations and additions it succeeded admirably in giving an equal blast. With these fans I connected a very small train of wheel-work, which, after many modifications, imparted to them the exact velocity necessary for supplying the proper ratio of air to the naphtha vapour. This machine, actuated by a mainspring and maintaining power, afforded a constant blast for eight hours; it might then be wound up without stopping the fans or extinguishing the light.

" Many difficulties still arose, such as the necessity of apportioning the diameter of the holes in the burner; the capacity and number of the air passages in the burner; the length of the burner, and its distance from the naphtha; the number and situation of the holes in the tube which distributed the atmospheric air to the naphtha vapour. Various trials surmounted all of them.

" But a chief difficulty was to find a remedy for the consequences of change of temperature in the apartment where the lamp burns. If the temperature be much raised, the lamp will smoke; if it be much lowered, the light will become feeble; but if maintained without much change of temperature, the light will not alter. Several methods were tried; such as cooling or heating the naphtha by increased or diminished speed of the fans; removing the supply of naphtha farther from, or bringing it nearer to the source of heat, and other minor expedients; but none of them acted satisfactorily.

" A method was then adopted which proved successful. In this lamp, the current of air impelled by the fans had been made to pass over the naphtha in hundreds of streams before it could arrive at the burner. By allowing a sufficient quantity of common air to mix with the naphthalized air, as it passed into the chambers of the burner, a degree of dilution would be produced that would cause the mixture to burn with a pure white light.

"On constructing the lamp with various valves to effect this object, I found that, unless the common air intended for dilution were allowed to mix with the naphthalized air in several streams, the common air would take a direction through one or other of the gas-ways of the burner, and the resulting flame would be yellow in one part, blue in another, and white in a third. By passing the common air in a number of streams a perfect commixture was effected; and by means of a lever outside of the lamp I was enabled to increase or lessen the tenuity of the streams, so that the body of the flame at the burner might be rendered less or more dense, or changed to a flame that should show no light, or to a smoky one. Perfect control was thus established.

"I have found by experiments conducted on a very large scale, that one hundred gallons of naphtha, of s. g. 0·846, distilled from Parrot coal tar, are, in burning with common air, equal, in the light produced, to 122 gallons of the best spermaceti oil. The comparison was made with Argand lamps and lamps of my construction, both showing the same diameter of flame. Other experiments made on a small scale, with photometers of different kinds, gave results a little different. In one trial 100 measures of naphtha equalled 120 of oil; in a second 128 of oil; in a third 130. Assuming 125 to be the number, and taking naphtha at 3*s.* 6*d.* per gallon, and spermaceti oil at double that sum, the oil lights will be two and a half times more expensive than the naphtha lights.

"I made photometrical experiments on the comparison of my lights with common gas lights, the result of which was, that, under proper management, and taking equal volumes of the two flames, my lights had two and a half times the illuminating power of common gas lights.

"Lest any apprehension should exist relative to the consequences of oversetting a lamp containing so inflammable a liquid as naphtha, with a flame burning at the only issue through which naphtha could pass, it is proper to state that the moment any one of the four sides of the lamp is raised half an inch from the table, as in the act of overturning, the lamp spontaneously extinguishes itself. In any case, little naphtha can be spilled; and that little will not leave the slightest stain on the most delicately tinted carpet, or even on silk, as it will dry out perfectly if the naphtha be pure. By another contrivance, the lamp may be moved from place to place without extinction of the flame.

"There is nothing in the construction of the lamp which should render it unmanageable in the hands of a servant of ordinary intelligence. Although even the purest naphtha has a smell equally disagreeable with and resembling common gas, not even the slightest odour can be perceived from it in burning.

"The new table-lamp may be thrown into a variety of shapes, some of them as graceful as any of those now in use, but in that case involving more complication than the one now exhibited.

"It is to be observed that this lamp cannot easily be kindled when the temperature of itself and contents is below 40°. The best mode is to pour in the naphtha immediately before it is required, and then it will kindle at ordinary temperatures, but will show little light for a few minutes; the light will then rapidly increase. If the naphtha contained in its proper supply-can be warmed to 80° or 90° by being placed for some time before the fire, and then poured in, the lamp on being kindled will show excellent light at once."

The Rev. Charles Graves read the following note "on the Theory of Linear Differential Equations."

The equation

$$D^n y + A_1 D^{n-1} y + A_2 D^{n-2} y + \ldots\ldots + A_n y = X, \qquad (1)$$

in which A_1, A_2, ... A_n, and X, are any functions of x, and D stands for the symbol $\frac{d}{dx}$, may be brought, after n integrations, into the form

$$y + D^{-n} A_1 D^{n-1} y + D^{-n} A_2 D^{n-2} y + \ldots + D^{-n} A_n y = D^{-n} X \\ + c_0 + c_1 x + \ldots c_{n-1} x^{n-1};$$

and this may be written as follows:

$$\phi(y) = D^{-n} X + c_0 + c_1 x + c_2 x^2 + \ldots c_{n-1} x^{n-1};$$

if we employ ϕ to denote the complex distributive operation

$$1 + D^{-n} A_1 D^{n-1} + D^{-n} A_2 D^{n-2} \ldots + D^{-n} A_n.$$

Operating now with the symbol ϕ^{-1} upon both sides of the last equation, we obtain the complete integral of the proposed one in the form

$$y = \phi^{-1}(D^{-n} X) + c_0 \phi^{-1}(1) + c_1 \phi^{-1}(x) + c_2 \phi^{-1}(x^2) \ldots + c_{n-1} \phi^{n-1}(x^{n-1}).$$

The term $\phi^{-1}(D^{-n} X)$ is evidently a particular integral of the proposed equation; whilst $\phi^{-1}(1)$, $\phi^{-1}(x) \ldots \phi^{-1}(x^{n-1})$ are particular integrals of the equation

$$D^n y + A_1 D^{n-1} y + A_2 D^{n-2} y + \ldots + A_n y = 0. \qquad (2)$$

This demonstration of the presence of n arbitrary constants in the complete integral, and of the mode of its composition, seems more simple and direct than those which are commonly given.

Putting U, u_0, u_1, $u_2 \ldots u_{n-1}$ in place of $\phi^{-1}(D^{-n} X)$, $\phi^{-1}(1)$, $\phi^{-1}(x)$, $\phi^{-1}(x^2) \ldots \phi^{-1}(x^{n-1})$, we may write

$$y - U = c_0 u_0 + c_1 u_1 + \ldots + c_{n-1} u_{n-1};$$

and differentiating this equation n times successively we have

$$\begin{aligned}
Dy - DU &= c_0 Du_0 + c_1 Du_1 + \ldots + c_{n-1} Du_{n-1} \\
D^2y - D^2U &= c_0 D^2u_0 + c_1 D^2u_1 + \ldots + c_{n-1} D^2u_{n-1} \\
\cdots\cdots &= \cdots\cdots\cdots\cdots\cdots\cdots \\
D^ny - D^nU &= c_0 D^nu_0 + c_1 D^nu^1 + \ldots + c_{n-1} D^nu_{n-1}.
\end{aligned}$$

The equation obtained by the elimination of the n constants $c_0, c_1, c_2, \ldots c_{n-1}$, from these last $n+1$ equations, being compared with the proposed equation (1), furnishes us with remarkable results.

The resulting equation* is

$$\begin{aligned}
&S(\pm u_0 Du_1 D^2u_2 \ldots D^{n-1}u_{n-1} D^ny) \\
&= S(\pm u_0 Du_1 D^2u_2 \ldots D^{n-1}u_{n-1} D^nU),
\end{aligned}$$

which, being arranged according to the differential coefficients of y, becomes

$$\begin{aligned}
&S(\pm u_0 Du_1 D^2u_2 \ldots D^{n-2}u_{n-2} D^{n-1}u_{n-1}) D^ny \\
&- S(\pm u_0 Du_1 D^2u_2 \ldots D^{n-2}u_{n-2} D^nu_{n-1}) D^{n-1}y + \ldots \\
&\ldots \pm S(\pm u_0 D^2u_1 D^3u_2 \ldots D^{n-1}u_{n-2} D^nu_{n-1}) Dy \\
&\mp S(\pm Du_0 D^2u_1 \ldots D^{n-1}u_{n-2} D^nu_{n-1}) y \\
&= S(\pm u_0 Du_1 D^2u_2 \ldots D^{n-1}u_{n-1} D^nU).
\end{aligned}$$

Putting this expression, for the sake of brevity, into the form

$$S_nD^ny - S_{n-1}D^{n-1}y + \ldots \pm S_1Dy \mp S_0y = S',$$

we have the following relations:

$$-S_{n-1} = A_1 . S_n \qquad (3)$$

$$S_{n-2} = A_2 . S_n \qquad (4)$$

$$\cdots\cdots = \cdots\cdots$$

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* $S(\pm u_0 Du_1 \ldots D^{n-1}u_{n-1} D^ny)$ is here used to denote the sum of all the terms derived from $u_0 Du_1 \ldots D^{n-1}u_{n-1} D^ny$ by the permutation of the elements $u_0, u_1 \ldots u_{n-1}, y$; each term being regarded as positive or negative according as it may be deduced from that first term by means of an odd or even number of interchanges of two letters.

$$\pm S_1 = A_{n-1}.S_n \qquad (5)$$
$$\mp S_0 = A_n.S_n \qquad (6)$$
$$S' = X.S_n,$$

the last of which shows that U, the particular integral of equation (1), is determined if u_0, u_1, $u_2 \ldots u_{n-1}$, the particular integrals of (2), be known. The remaining equations indicate the relations which exist between A_1, $A_2, \ldots A_n$, and u_0, u_1, $\ldots u_{n-1}$. We are not able to derive the integrals u_0, u_1, $\ldots$ u_{n-1} from the equations just given, any more than we can determine the roots of an algebraic equation from the well known relations between them and its coefficients. In fact, if we were to multiply the equations (3), (4), (5), (6) by $D^{n-1}u_0 D^{n-2}u_0 \ldots Du_0$, u_0, and add to their sum the identical equation,

$$S_n D^n u_0 = S_n D^n u_0,$$

we should eliminate the other roots $u_1\, u_2 \ldots u_{n-1}$, but at the same time reproduce the original differential equation.

All the preceding reasoning applies whenever D denotes, not merely the operation of taking the differential coefficient, but *any* distributive operation such that

$$D^n (c_0 + c_1 x + \ldots + c_{n-1} x^{n-1}) = 0.$$

The results obtained hold good, therefore, in the case of equations in finite differences.

As regards the case of differential equations, it is worthy of notice that the equation (3) admits of integration independently of any relation between the functions u_0, u_1, $\ldots u_{n-1}$. Since

$$S_{n-1} = D\,S_n,$$

we have

$$S\,(\pm u_0 Du_1 D^2u_2 \ldots D^{n-2}u_{n-2} D^{n-1}u_{n-1}) = e^{-\int A_1 dx.}$$

And it follows from this that the left hand member of equation (1) becomes a complete determinant when multiplied by $e^{-\int A_1 dx}$.

The problem of expressing the coefficients of the differential equation (2), in terms of its particular integrals, has been treated by M. G. Libri, in a very elegant memoir on Linear Differential Equations, printed in the tenth volume of Crelle's Journal. He has given the following formula to determine A_1:

$$A_1 = -\frac{nDu_0}{u_0} - \frac{(n-1)\,D^2\left(\frac{u_1}{u_0}\right)}{D\left(\frac{u_1}{u_0}\right)} - \frac{(n-2)\,D^2\left(\frac{D\left(\frac{u^2}{u_0}\right)}{D\left(\frac{u_1}{u_0}\right)}\right)}{D\left(\frac{D\left(\frac{u^2}{u_0}\right)}{D\left(\frac{u_1}{u_0}\right)}\right)} - \&c.,$$

and merely indicated the method of obtaining expressions for the other coefficients. From the nature of this method, however, it is easy to see that it would be scarcely possible to write down the values of the higher coefficients, in terms of u_0, u_1, &c., on account of their extreme complexity. M. Libri has noticed that the expression given above for A_1 is, from the nature of the case, a symmetrical function of u_0, u_1, &c.; though this is not indicated by its actual form. To exhibit it as a symmetrical function of those particular integrals we must execute in it all their possible permutations, and then take the sum of the results. This operation considerably increases the complexity of the formula.

[In the notice of Mr. Donovan's Lamp (p. 75), it was omitted to be stated that it burned with a brilliant light during the sitting of the Academy.]

March 16th, 1848. (Stated Meeting).

REV. HUMPHREY LLOYD, D. D., PRESIDENT, in the Chair.

THE following Report from the Council was read by the Secretary:

The Council are happy to be able to announce that the second part of the twenty-first volume of the Transactions of the Academy is now ready, and will be delivered to Members in a few days.

It contains some very valuable papers, in each of the three departments of the Academy's objects: amongst which it may suffice to particularize, in the department of Science, Mr. Haughton's very beautiful Essay on the Equilibrium and Motion of solid and fluid Bodies; and Sir William Hamilton's theory of Quaternions. This theory is as yet in its infancy, but there is every reason to believe that it will ultimately become a recognised branch of Mathematics. If so, the Academy will share with its illustrious author in the honour of having produced the greatest improvement in pure analysis that has been made since the time of Des Cartes. The application of this Calculus to the theory of the Moon has already been found to introduce great simplifications into the laborious and complicated investigations necessary in the ordinary method of co-ordinates; and has solved the Newtonian problem of the disturbance of the moon by the sun, to the extent of the third dimension of the distance. In its application to the system of the world, the well-known principles of the conservation of the *vis viva*, and of areas, and other laws of planetary motions in their most general form, are amongst the earliest and most elementary of its results.

Another important feature of the volume will be found to be the papers in the department of Polite Literature, by Dr. Hincks and Dr. Wall, upon the Hieroglyphic or ancient Egyptian alphabet, and upon the three kinds of Persepolitan Writing. These subjects, it is well known, have already engaged the attention of the most eminent scholars of Europe, and it is hoped that the additional light thrown on them in the present volume of the Transactions will be recognised with interest by the learned world, and add to the reputation already so justly earned by the authors of the papers referred to.

The Proceedings have been published during the past year with great regularity, and an inspection of them will show that there has been no lack of valuable communications, on various branches of Science and Antiquities, at the meetings of the Academy during that period.

The most important subject which has occupied the attention of the Council during the past year, is one upon which their deliberations have only just closed, and they have now to make known the result to the Academy for the first time.

The regulations for awarding Medals and prizes from the Cuningham bequest, have long been felt to be unsatisfactory, and have not been found to work well. The Council accordingly have given the subject much consideration, and have resolved to adopt a modification of the former rules which it is hoped will have a beneficial operation.

Hitherto the Medals, as the Academy are aware, were given only to the authors of papers published in the Transactions; it is now resolved to include, in the list of eligible candidates for this distinction, the authors of all works of merit printed and published in Ireland, or relating to Irish subjects. It has been thought right to make this limit, because it is obvious that a limitation of some kind is necessary, and this appeared to be directly pointed out by the intention of the Cunningham bequest, which was manifestly designed to encourage the pursuit of learning in this country.

Another very important alteration in the former rules is this:— It has been resolved to offer prizes in money for Reports or Essays on given subjects, in theoretical and practical Science, Antiquities, and other departments of Literature. This, it is hoped, will be found to open up a new field for a most useful application of the fund. It will enable the Academy to obtain from the persons best qualified an account of the progress and actual state of our knowledge, with statistical details, if necessary, of a practical and useful character. An important machinery will thus be within our reach for directing public attention to scientific or antiquarian subjects, and for collecting and preserving information that would otherwise, perhaps, be inevitably lost; and it will always be in the power of the Academy to select the most competent person for making such Reports; and to award to him a prize proportioned in value to the time and cost of the investigation, or else to throw the prize open to competition, and to adjudge the reward to the Essay that is found to be the most complete and satisfactory.

The following are the regulations as finally agreed to by the Council:

"1. That Medals given under the Cunningham bequest be open to the authors of all works or essays in the departments of Science, Polite Literature, or Antiquities, which shall be printed and published in Ireland, or which shall relate to Irish subjects.

"2. That the award of Medals be taken into consideration by the Council every third year, at the first meeting after the 16th of March, and that it be confined to papers or works published within the six years preceding.

"3. That the Council shall, from time to time, grant money premiums for Reports or Essays upon stated subjects, reserving to themselves the power of printing the papers or not, as they deem expedient.

"4. That at the next award of Medals, the papers contained in Vols. XIX. and XXI. be taken into consideration.

"5. That the existing regulations, as to the manner of deciding on papers for Medals, shall continue in force."

The Library during the past year has been enlarged by several valuable donations, which have been acknowledged from time to time in the Proceedings. It has also been added to by purchase: but, from the limited funds at the disposal of the Council, these purchases have necessarily been but few, amounting in all to the sum of £99 10*s*., which includes the annual subscriptions of the Academy to scientific and literary Journals and Reviews.

The Museum has also received many valuable donations, which have been enumerated in the Proceedings. Among them it may be permitted to the Council to notice, from their peculiar magnitude and value, the Antiquities presented by Lord Farnham, and by our constant benefactors, the Shannon Commissioners, to whom the special thanks of the Academy were voted for additions to our National Museum of very singular interest and importance. The Museum has also been increased during the past year by purchases made out of the funds placed by the Academy in the hands of the Committee of Antiquities for that purpose, to the amount of £61 10*s*. 6*d*.

The Council recommended to the attention of the Academy, in the course of last summer, the important work undertaken at the suggestion of the Committee of Antiquities, of investigating the interior of the ancient Tumulus of Dowth. As the Committee have not yet made their Report on the results of the excavations, it is only necessary to congratulate the Academy in general terms on the commencement that has been made, by these operations, of a scientific and dispassionate examination of our ancient monuments. Nor will the cost of the work be a subject of regret, when it is remembered that these singular structures are almost the only records that exist of the people who were perhaps the first colonists of Ireland, and whose progress may be traced, by the existence of similar monuments, over a large portion of the north of Europe. The importance of such investigations, therefore, considered as a source of history, and as a means of mapping the migrations of the human race, can scarcely be overrated. But for the present the operations of the Committee have been suspended for want of funds; they hope, however, very soon to lay before the Academy a full account of what has been done, together with sectional plans and drawings, for which they are indebted to Mr. Frith. To the professional skill and disinterested co-operation of that gentleman they are under great obligations, as well as for the constant superintendence he has given to the work, without which it would have been impossible for the Committee to have completed their operations with the strict attention to economy which has been observed.

Another subject of national interest has also engaged the attention of the Council during the past year.

Sir William Betham having intimated to the Council that he was anxious to dispose of his collection of Irish MSS., a Committee was appointed to examine them and report on their value The result was an offer on the part of Sir William Betham to sell the MSS. to the Academy for the sum of £1000, which he subsequently reduced to £800, from his wish to have them preserved in Ireland, although he could have obtained (as the Council are assured) the original sum at which he valued them, if he would consent to dispose of them elsewhere. The Committee having reported that the Manuscripts were well worth the price expected for them, and that they would be a valuable addition to our Library, it was resolved to make an attempt to raise the sum required. A new demand was, with great reluctance, made on the liberality of our Members and of the public: the subscription list was headed by a donation of £100 from the Academy, and a memorial was presented to the Lord Lieutenant, in the hope of obtaining a portion of the purchase-money for this national object, through his Excellency's influence with Her Majesty's Government.

The final answer to this memorial has not yet been received. His Excellency has expressed the warmest interest in the object proposed, but it is obvious that the present financial condition of the country renders the present a peculiarly unpropitious time for an application to Government for such a purpose. The subscriptions already promised do not amount to above a third of the required sum; and it is to be feared that, unless a very great exertion is made, Sir William Betham will be compelled to dispose of his manuscripts elsewhere.

During the past year twenty-five new Members have been elected into the Academy, and we have lost, by death, four honorary and eight ordinary Members; so that the total number of Members now on the list of the Academy is,

Honorary, ...	61
Ordinary, ...	395
Total, . .	456

The new Members elected during the year now closed are the following:

Abraham Whyte Baker, Jun., Esq.
James W. Middleton Berry, Esq.
Richard Vicars Boyle, Esq.
Right Hon. Sir Thomas Esmonde, Bart.
Nathaniel Hone, Esq.

Philip Jones, Esq.
Edward Barnes, Esq.
Henry Freke, M. D.
Arthur Sidney Ormsby, Esq.
John C. Egan, M. D.
Eaton Hodgkinson, Esq.
Henry Croly, M. D.
John Grene, Esq.
Alexander H. Haliday, Esq.
James Hartley, Esq.
Wm. Thos. Lett, Esq., F. T. C. D.
George Miller, Esq.
Henry Wilson, M. D.
Frederick Clarendon, Esq.
Rev. Matthew Newport, D. D.
Charles Ottley, Esq.
O'Neale Segrave, Esq.
Matthew E. Talbot, Esq.
Charles Tarrant, Esq.
Rev. J. J. Taylor, D. D.

We have also to lament the decease in the same period of several very eminent Members of our body. Among them are the following Honorary Members:

NICHOLAS CARLISLE, Esq., who died at Margate on the 27th of August, 1847, in the seventy-seventh year of his age. Mr. Carlisle was one of the Secretaries of the Society of Antiquaries, an office which he had filled for a period of more than forty years. He is known by his very valuable works on topography and heraldry.

MISS CAROLINE LUCRETIA HERSCHEL, who died at Hanover, on the 9th of January, 1847, at the very advanced age of 98. Miss Herschel was sister to the celebrated astronomer, Sir William Herschel. She was born at Hanover, March 16, 1750, and in 1772 removed to England to join her brother, who was then at Bath, engaged in the profession of a musician. When he commenced his astronomical pursuits she was his constant assistant, both as a calculator and as an observer, for which duties she subsequently received a salary from the munificence of George III. She was also engaged in constant labours of her own, made with a small Newtonian telescope, which stood on the lawn of her brother's house, and with which she was in the habit of making regular observations. The following extract from the address of Sir James South, on presenting her with the Medal of the Astronomical Society, on the 8th of February, 1828, will explain the nature and success of these labours:

"But her claims to our gratitude end not here; as an original observer she demands, and I am sure she has, our most unfeigned thanks. Occasionally her immediate attendance during the observations could be dispensed with. Did she pass the night in repose? No such thing; wherever her illustrious brother was, there you were sure to find her also. A sweeper planted on the lawn became her object of amusement; but her amusements were of the higher order, and to them we stand indebted for the discovery of the comet of 1786, of the comet of 1788, of the comet of 1791, of the comet of 1793, and of the comet of 1795, since rendered familiar to us by the remarkable discovery of Encke. Many also of the nebulæ contained in Sir William Herschel's catalogues were detected by her during those hours of enjoyment. Indeed, in looking at the joint labours of those extraordinary personages, we scarcely know whether most to admire the intellectual power of the brother, or the unconquerable industry of the sister.

" In the year 1797, she presented to the Royal Society a catalogue of 560 stars taken from Flamsteed's observations, and not inserted in the British Catalogue; together with a collection of errata that should be noticed in the same volume.

" Shortly after the death of her brother, Miss Herschel returned to Hanover. Unwilling, however, to relinquish her astronomical labours whilst anything useful presented itself, she undertook and completed the laborious reduction of the places of 2500 nebulæ, to the 1st January, 1800, presenting in one view the results of all Sir William Herschel's observations on these bodies ; thus bringing to a close half a century spent in astronomical labour."*

For this last laborious and useful work she was presented with the medal of the Astronomical Society of London in the year 1828, and afterwards elected an Honorary Member of that body. For the same work she was also subsequently elected an Honorary Member of this Academy, November 12, 1838.

M. ALEXANDRE BROGNIART, at the age of 78, died about the beginning of October last; the exact day has not been ascertained. He was a native of Paris, where he was born about the year 1773. In 1800 he was appointed to the office of superintendent of the national manufactory of porcelain at Sèvres, in which employment he continued to his death. Before that time, however, he was known as a mining engineer, and had published a treatise on enamelling, which attracted the attention of M. Berthollet, and procured for him the appointment of the porcelain works at Sêvres, which he held till his death. In 1807 he published his "Traitè élémentaire de Mineralogie," a work which still maintains its high character. He was also an eminent student in zoology and geology, on which latter subject he is known by his work, published in 1822, in conjunction with Cuvier, on the geology of the environs of Paris.

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* Memoirs of the Astronomical Society, vol. iii. p. 410.

He was elected a Member of the French Academy in 1815, and in the same year he became a Foreign Member of the Royal Society, of London. In June, 1825, he was elected an Honorary Member of this Academy.

In practical science he is known by his works on pottery, suggested by his situation as superintendent of the great manufactory at Sêvres.*

We have also to record the decease of another eminent Honorary Member, DR. THOMAS TAYLOR, who was carried off, by fever, in the early part of last month.

Dr. Taylor was one of the most distinguished cryptogamic botanists of the present day. Ardently attached to botany from very early years, and endowed with an acute eye, and keenly-discriminative powers of mind, he soon became known as an observer; and to his researches the Irish Flora is indebted for the detection of a large number of new species.

These researches continued with unabated zeal through life. In 1818, in conjunction with Sir William Hooker, he published the "Muscologia Britannica," a work which, for accuracy and clearness has seldom been surpassed, and which is still the best guide to a knowledge of the British mosses. In 1827 it went through a second edition. His other botanical writings are: an elaborate monograph of the *Marchanticæ*, published in the seventeenth volume of the Transactions of the Linnæan Society of London; the articles *Mosses* and *Lichens* in the Flora Hibernica; and numerous papers in Hooker's London Journal of Botany, chiefly on exotic cryptogamia. Besides these, he assisted Dr. Joseph Hooker in the cryptogamic portion of the Flora Antarctica. During some years Dr. Taylor was Lecturer on Botany and Natural History in the Royal Cork Institution; but on the withdrawal of the parliamentary grant he retired to an estate in the County Kerry, near Kenmare, where he continued to reside for the remainder of his life, employing himself in country business, and devoting to botany his leisure time. As a magistrate, he twice received the marked thanks of the Government. In the late season of awful misery, his purse and his medical skill were freely employed in alleviating the sufferings of his poorer neighbours; and it was *fever*, caught in the discharge of his duties at the workhouse of Kenmare, to which he was physician, which terminated his useful life at an age very little exceeding 60. Strong in frame, and remarkably active, he might have looked forward to a more lengthened career.

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* See the notice of M. Brogniart, in the Address delivered by the Marquis of Northampton to the Royal Society, on the 30th of November last.

Dr. Taylor was in correspondence with the most celebrated botanists of England, France, Germany, and America, by whom he was universally esteemed. "He possessed," in the language of an early friend, "a mind well stored in the various branches of science and literature, while his gentle and amiable manners rendered him a great favourite with all who had the happiness of his acquaintance." His loss is deplored by a wide circle of scientific and personal friends. He received the well merited honour which has connected his name with this Academy in the year 1816.

We have also lost by death, during the past year, eight ordinary members, whose names are as follows:

The Rev. John Cramer Roberts, elected a member of the Academy, 28th April, 1792.

Samuel Litton, Esq., M. D., elected 16th March, 1815.

James Mac Cullagh, Esq., LL.D., elected February 25, 1832.

William Hill, Esq., elected 10th June, 1839.

The Rev. Robert Trail, D. D., elected 13th April, 1840.

Joseph Nelson, Esq., Q. C., elected 1st February, 1842.

James Jameson, Esq., elected 14th April, 1845.

John Oliver Curran, Esq., M. B., elected 13th April, 1846.

DR. SAMUEL LITTON was one whose literary attainments and private virtues endeared him to all who had the privilege of his acquaintance. He was the son of Mr. Edward Litton, who, although a native of Ireland, had settled in Liverpool, where, after the failure of some commercial speculations, he became the master of a mercantile school, and acquired a high literary reputation. Our late lamented friend was, therefore, a native of Lancashire; and in the year 1795 he entered Trinity College, Dublin, having selected for his tutor the late Dr. Magee, then a Fellow of the College, and subsequently Archbishop of Dublin. It was usual then, as it is now, for the students from that part of England to return to their friends after each examination, and this course appears to have been adopted by young Litton, until his election to a scholarship rendered his residence in the College a matter of necessity. As intercourse by sea with Liverpool was not then as easy as it is now, it is no cause of wonder that Litton, although eminently distinguished in the undergraduate course, failed to fulfil the conditions that were then necessary for obtaining the gold medal at the degree examination. It will be remembered that this medal was then given, not, as now, to the best answerer at a severe examination, but to the student who, during his whole undergraduate course, had never omitted an examination nor obtained, at any one examination, judgments below a certain standard. In point of fact, the gold medals in Dr. Litton's class, which graduated in 1800, were obtained by the present Vice-Provost, and by another very eminent scholar, the lamented John Ormston.

At his graduation in 1800, Litton must have been about twenty-three or twenty-four years of age; and he appears at first to have contemplated studying for a fellowship. At the fellowship examination of 1801, however, he did not sit, for his father died at the close of the year 1800; and this circumstance, requiring him to be absent from College, would naturally have interfered with his studies, even if the time had sufficed to enable him to prepare himself with any prospect of success.

From 1801 to 1805 there was no vacancy for fellowships; and although during that period young Litton continued occasionally to attend the mathematical lectures, yet when the time came he did not present himself as a candidate. The fact is, that his habits of general discursive reading, his taste for natural history and botany, and for the lighter branches of literature, were inconsistent with the severe and condensed application which the fellowship examination requires.

Dr. Litton was probably decided to devote himself to the medical profession by his predilection for the natural sciences, and by his intimacy with the late eminent Dr. Robert Perceval, of Manchester. He took his medical degree at Edinburgh, in the year 1806.

In 1809, on the death of Dr. Robert Scott, he was a candidate for the chair of botany in the University, to which the late Dr. Allman was then elected. But soon afterwards he was elected Professor of Natural Philosophy to the Dublin Institution, where he delivered lectures that attracted much attention. He was also a Fellow of the College of Physicians, one of the Physicians to the House of Industry, and Professor of Natural History to the Apothecaries' Hall. But he was chiefly known by his long connexion with the Royal Dublin Society. He was elected Librarian to that institution in 1814, and Professor of Botany in 1826, which latter office he enjoyed till his death.

In 1815 he was elected a member of the Academy, and in the following year he was placed on the council, where he continued to serve to the day of his death, a period of thirty-one years. In 1833 he was appointed Vice-President of the Academy, in which office he continued until 1840, when he resigned to make way for the new rule of rotation then agreed upon.

His death was very sudden. On the day of his death he delivered his usual lecture in the Theatre of the Royal Dublin Society; and afterwards, although he had been complaining during the day of indisposition, he went to dine with a friend at Rathmines. He left the house at eight o'clock, and after walking some distance, was seized with such violent pains in the chest as to attract the notice of a gentleman passing by, who kindly placed him on a car, and accompanied him to Dr. Leet's, in St. Stephen's-green, where he soon after expired. His disease was angina pectoris, and his death took place on the 4th of June, 1847.*

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* A short Memoir of Dr. Litton, with an engraving, has appeared in the Dublin University Magazine.

Another eminent Member of Council, who has largely contributed to the fame of this Academy, and of the University to which he belonged, was JAMES MAC CULLAGH.

He was born in the County Tyrone, in the year 1809, in the parish of Upper Badony, about ten miles from Strabane. At a very early period of his life he was put to school at Strabane, to which town his father had removed, chiefly for the purpose of obtaining the means of education for his son. His taste for mathematical pursuits was soon perceived, but from the want of well qualified instructors, he had great difficulties to contend with. It is said that he was set to learn the demonstrations of Euclid by heart, without any reference to the diagrams, or any attempt to understand the reasoning. This was peculiarly distateful to his active and inquiring genius, and produced an uneasiness which caused a rebellion in his mind against the unintellectual task to which he was condemned. In his distress, it is said that he was led accidentally to communicate his perplexity to a neighbour, a working carpenter, but a man of some intelligence and information, who had the high honour of first communicating to the mind of Mac Cullagh the perception of a geometrical demonstration.

Having outstripped his teachers at Strabane, he was sent to the school of the Rev. John Graham, at Lifford, and afterwards to that of the Rev. Thomas Rollestone. He entered Trinity College, Dublin, in November, 1824, as a pensioner, and in the following year he obtained a sizarship. Throughout his undergraduate course he was eminently successful both in classics and science. In 1827 he was elected a scholar, and in 1832 he obtained a fellowship.

In 1835 the Professorship of Mathematics having been placed under new regulations, in virtue of a Statute then recently obtained from the Crown, Dr. Sadleir, the present Provost, resigned the office, and Mac Cullagh was appointed Professor.

In February, 1833, he was elected a Member of the Academy, and in 1838 was put upon the Council, where he continued to serve to the day of his death. In 1844 he was elected Secretary to the Academy, which office he resigned at the beginning of 1846.

In 1843, the Chair of Natural Philosophy in the University became vacant, by the appointment of Dr. Lloyd to a senior fellowship, and Mac Cullagh was elected to it without opposition.

These are the principal events and dates of a life spent in the peaceful pursuits of learning, and in the diligent discharge of academic duties. In reviewing the labours which were the result of that life, it will be necessary, in the first instance, to give some account of the papers published in the Transactions of this Academy, containing the researches in Mathematical and Physical Science, on which the fame of Mac Cullagh chiefly rests.

His first papers were read here, before he had become a Member of the Academy, and before he was elected a Fellow of the College. They were communicated to the Academy by Dr Sadleir, the present Provost, and by our late lamented President, Provost Lloyd, that ardent patron of learning and talent, to whose affectionate and constant encouragement Mac Cullagh, in common with many others who have since distinguished themselves in the University, owed much of his subsequent success.

Previous to this, however, and whilst he was an undergraduate in the University, he had completed a new and original theory of the rotation of a solid body round a fixed point, of which he furnished a brief sketch to Provost Lloyd ; this paper he did not publish, finding that he was anticipated in a portion of it by Poinsot, as we shall hereafter have occasion to notice.

The next subject to which he turned his attention was the Wave Theory of Light, in which he afterwards became so eminent. At that time the laws of Double Refraction had been discovered by Fresnel; but to explain those laws on mechanical principles, that author had recourse to an hypothesis, simple, certainly, but so improbable as to be now considered inadmissible; from that hypothesis he succeeded in deducing the laws at which he had previously arrived, but by a process of calculation so complex, repulsive, and difficult, as to be almost unpresentable. It was on this subject that Professor Mac Cullagh communicated to the Academy his first paper, read June 21, 1830. Struck with the elegance of the laws, and with the simplicity of the hypothesis by which they were explained, he was dissatisfied with the difficulty of the process employed by Fresnel; and taking up the subject on the same hypothesis, although never satisfied with it, he succeeded in deducing all the laws from the simplest geometrical considerations. In this first communication there was no new *physical* discovery, nor anything which had not been previously known, although there was abundance to show the original genius and power of the author, as well as much purely *mathematical*, which was perfectly new. On the same day he communicated also another paper on the "Rectification of the Conic Sections," and that again displayed no new *results*, but, like the other, simplicity and elegance of method. Since that period, however, he did arrive at several new and very beautiful theorems in that interesting subject, the chief of which will be found published in his Examination Papers in the Dublin University Calendar.

His next paper was read in the year he obtained fellowship, on the 28th of May, 1832. It originated in a contest between Laplace, Lagrange, and Sir James Ivory, in which the two latter denied the truth of an approximate theorem in the subject of attractions discovered by the former. In that paper Mac Cullagh showed, in the most simple and elegant manner, that the objectors were wrong, and that Laplace was right.

His next paper was read on the 24th of June, 1835, and was entitled "Geometrical Propositions applied to the Wave Theory of Light." In this again, although he displayed great originality, acuteness, and *geometrical* elegance, he arrived at no *physical* results which could be called strictly original, for his *two* cases of "Conical Refraction" had been previously discovered theoretically by Sir William Hamilton, and confirmed experimentally by Dr. Lloyd.

His first altogether original paper was read to the Academy on the 22nd of February, 1836. In that paper, he linked together, by a single and simple mathematical hypothesis, the peculiar and unique laws which govern the motion of light in its propagation through quartz; and having determined by observation of one set of phenomena the value of a particular constant occurring in his theory, he subjected that theory to the severe test of calculating numerically the results of another and wholly different set of phenomena, and thence compared the results with observation, before he gave the theory in its published form to the Academy.

His next paper was also on the subject of Light, and in it again he made a great advance beyond the knowledge of the time. It was read to the Academy on the 9th of January, 1837, and was entitled, "On the Laws of crystalline Reflexion and Refraction." The problem discussed in that paper was completely solved and reduced to geometrical laws of the greatest simplicity and elegance, which had been but partially solved by Fresnel, in the particular case of *ordinary* media; and even this limited solution depended on inaccurate principles, and only gave the right results by a balancing of opposite errors. The laws discovered by Mac Cullagh in this paper were deduced from *four hypotheses*, unestablished certainly, but highly probable from their great simplicity and accordance with all previous physical notions. The truth of these hypotheses was *then* confirmed by their leading to results conformable to observation, but as yet they had not been accounted for on a single mechanical principle. It was in reference to the results published in this paper that Mr. Neumann, of Königsberg, subsequently advanced a claim of priority. The letter of Mr. Neumann to Sir William Hamilton, then President of the Academy, will be found in the first volume of the Proceedings; and the masterly defence of his own claims made by Professor Mac Cullagh, has been published in the pages immediately succeeding. He has there shewn that he was indebted to no man living for assistance on the subject of light, save to Fresnel alone; and his vindication of himself is so complete, that nothing more need be here said on the subject, except to remark that the results of greatest importance had not been arrived at by Mr. Neumann. Both had set out, independently of each other, from the same principles, and both had completely solved the question *analytically*, but the *geometrical interpretation* of the laws had been given by Professor Mac Cullagh only.

His next paper was presented to the Academy on the 9th of December, 1839. It was on "The *Dynamical* Theory of Crystalline Reflexion and Refraction." In this he verified all his preceding predictions respecting the laws of propagation and reflection, by showing that both sets of laws, although so widely different in their nature, had, nevertheless, a common origin in a higher and more ultimate law, from which they were but particular deductions. In this paper he succeeded in deducing from a single physical hypothesis, and from strictly mechanical principles, all the known laws of crystalline propagation, reflection, and refraction.

This new theory he has since applied to the hitherto undiscovered laws of *total* reflection, and had succeeded in completely solving the problem in the particular case of an ordinary medium. This he has noticed in different places in the third volume of the Proceedings of the Academy. He had also succeeded in developing the whole problem in the general case, although in its complete form his theory was never published.

While he was thus discovering the true laws of that branch of physical science, he saw that a false theory on the same subject was proposed on the continent, and that, from the great name of its originator, it was gaining ground even in his own University. He immediately came forward and exposed the many errors and inconsistencies of that theory. This refutation will be found in the Proceedings of the Academy, Vol. II., page 189.

During all this period he also read before the Academy some highly original papers on purely mathematical subjects. Of these his paper "On Surfaces of the Second Order," published in the Proceedings, Vol. III., would have sufficed, had he written nothing else, to establish his reputation as a mathematician.

In 1838 Professor Mac Cullagh received from the Royal Irish Academy the Cunningham Medal, for his paper "On the Laws of Crystalline Reflection and Refraction." On presenting him with that medal, Sir William Hamilton, who was then our President, delivered an Address, which is printed in the Proceedings, and which contains a concise account of the then existing state of science, and a just tribute to the value of Mac Cullagh's discoveries.

In 1842 a still further recognition of his merits was made by the Royal Society, who awarded him the Copley Medal for his investigations in the theory of Light. On this occasion he had among his competitors for this high honour, Bessel, Dumas, and Murchison.

But it would be a great error to estimate the services which

Professor Mac Cullagh has rendered to the cause of science merely by his published works. The School of Mathematics, which was founded in the University by the writings, the example, and the energy of Provost Lloyd, owes much of the success that has continued to attend it, since the death of its founder, to the zeal and spirit of Mac Cullagh. His lectures, first in the chair of Mathematics, and for the last four years in the chair of Natural Philosophy, have undoubtedly given an impulse to the study of the severer sciences, which cannot be regarded without astonishment by those who remember the state of mathematical and physical learning in Trinity College when Provost Lloyd began his labours. The change seems almost incredible, when we consider the short period of time in which it has been effected, the great amount of scientific knowledge which is now common even among undergraduates, and the number of eminent young men who have imbibed the spirit of Mac Cullagh, and are ready to walk in his footsteps. In this more private sphere of usefulness Professor Mac Cullagh has done much to deserve the gratitude of his country, and the affectionate remembrance of his contemporaries in the University.

The following account of his lectures delivered to the candidates for Fellowships, as Professor of Natural Philosophy, is from the pen of one who has deeply profited by his instructions, and who now holds a high and well-merited station in Trinity College. It is contained in a letter written soon after his decease, and addressed to Sir William Hamilton.*

"I allude to these lectures, because it was in the delivery of them that Professor Mac Cullagh ever appeared to the greatest advantage; it was there that he used to display the extensive information, the elaborate research, and the vast acquired treasures of his highly cultivated mind; and it was there that he turned to account the noble faculty of inventive genius with which he was so eminently gifted, in improving, by means of it, every subject he ever handled. There is no one capable of appreciating such subjects, who will not agree with me, that during the several years of his purely mathematical lectures nothing could exceed the depth, or surpass the exquisite taste and elegance, of all his original conceptions, both in analysis and in the ancient geometry in which he delighted. Nor will it be denied, by any one who was so happy as to possess the opportunity of judging, that during the last three years and a half in which he filled the chair of Natural Philosophy, his earnest endeavour was to instil sound and accurate physical conceptions into the minds of his hearers, and to array them, when stated into mathematical language, in all the charms which result from true taste and refinement.

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* This letter was communicated to the Marquis of Northampton, as President of the Royal Society, and extracts from it have already appeared in the notice of Professor Mac Cullagh, given by his Lordship in his Address to that body, on the 30th of November last. See London, Edinburgh, and Dublin Philosophical Magazine, for March, 1848, p 219.

"In his first course of lectures (on the Rotation of a solid Body round a fixed Point), he completely solved the case of a body abandoned to its own motions, on receiving a primitive impulse in any direction, under the action of no accelerating forces. This problem he had finished several years before, and was preparing it for publication, when he was anticipated by Poinsot, who published a very elegant tract on the subject. Both theories are founded on the same principles, and exhibit the effects of the forces in different positions of the body, as well as the actual motions of the body itself, by means of an ellipsoid described round the fixed point as a centre. But they differ in employing, not the same but reciprocal ellipsoids, which, though seemingly unimportant, makes this difference, that Mac Cullagh's method, although not superior in clearness or elegance, had the prodigious advantage of enabling him to throw his geometry into the analytical form, and to deduce, from the simplest geometrical considerations, the elliptic integrals which expressed the circumstances of the motion, such as the times of oscillation, revolution, &c. This method also enabled him to find several interesting properties, which Poinsot's mode of treating the question did not so readily exhibit, and which Poinsot had in fact omitted to notice. Some of these results were since published by Professor Mac Cullagh in the Proceedings of the Academy. Indeed the whole discussion, which is in existence in its first form, as delivered by himself, is highly original, interesting, and instructive, and, notwithstanding its being partially anticipated by Poinsot, is well worthy of publication. . . . .

"In his course of lectures on Attractions he gave some very beautiful theorems respecting the attraction of a body of any nature and form, on a point distant a long way in comparison of its own dimensions; by an original and very ingenious method, he deduced the beautiful theorem of Chasles on the attractions of any two confocal ellipsoids on the same external point; and subsequently applying his results to the problem of the figure of the earth, he deduced with ease the well-known and celebrated theorem of Clairaut.

"In the same course of lectures he gave also some most simple and elegant geometrical methods for finding the laws of attraction of an homogeneous ellipsoid on any internal point, with several other ingenious and beautiful theorems, which it would be tedious to particularize. The subject of attractions seems indeed to have been a favourite one with him; on several previous occasions in the course of his lectures he gave new and beautiful theorems in it, and in many important respects improved the existing theories, keeping always in advance of the knowledge of his time. . . .

"I now come to his great course of lectures on 'The Dynamical Theory of Light,' the unaided creation of his own surpassing genius, and to the statement of the single and simple hypothesis upon which, as a basis (to borrow the language of Dr. Lloyd when speaking of Fresnel's beautiful theory of double refraction), Professor Mac Cullagh 'has reared the noblest fabric which has ever adorned the domain of physical science, Newton's system of the universe alone excepted.' When I say that *I* think Professor Mac Cullagh ranks as a philosopher higher than Fresnel in the region of Light (and if *that* be admitted he will certainly rank inferior to none on that subject), I do not at all institute any comparison between labours so different in their nature as those of these two great men. Professor Mac Cullagh, I conceive, stands to Fresnel in the same relation as Newton to Kepler. The latter, undoubtedly, discovered all the elegant laws of the *propagation* and double refraction of light in crystallized media, as well as those of ordinary with some of those of total *reflection* at the bounding surfaces of *ordinary* media, but he did not account for them on any correct mechanical principles. With respect to *propagation*, the very first principles from which he sets out are such as cannot be admitted; with respect to *ordinary* reflection, he partly accounted for them on correct principles, in the particular case of ordinary media; and with respect to *total* reflection, his beautiful empirical laws are well known, but he did not account for them at all, even in the simple case of ordinary media, which was the only one for which he had ever given them. Professor Mac Cullagh, on the contrary, not only deduced the known laws in all the three cases from mechanical principles of a nature so simple and probable, as that they cannot but bear conviction of their truth to any mind reflecting on them with anything like the attention they undoubtedly deserve; but he also gave the general equations of the motion of the propagation of light, not only in all known media, but also for *all* media which could ever be discovered, or even conceived; and with them he gave also the general conditions which must be fulfilled at the common bounding surface of every two not only known but conceivable media, and which in every case give all the laws of reflection and of refraction, whether ordinary or total. Thus did he deliver to us and to posterity a perfect and complete *mechanical* theory,—*analytically complete*,—so that any one who in future may attempt to *discover* in this region of science can only do so by treading in his steps, and adopting his correct principles, but can never supersede them; in fact he has discovered and handed down to us the *general principles* which *must* hold in all cases, and it remains for future investigators only to *apply* them. . . . .

"He himself applied them to the two most general cases of *propagation*, viz., of polarized waves of undiminishing intensity in a crystalline medium, and of that peculiar species of propagated vibrations which take place in the rarer medium, in every case of *total reflection* at the surface either of an ordinary or of a crystalline medium; in the former case he arrived at *all the laws of propagation* in *crystalline* media which were discovered by Fresnel, with one single variation, and that the very one on which he himself had long previously corrected Fresnel, viz., the vibrations of the ether, which in place of being *perpendicular* to the plane of polarization, as Fresnel had supposed, were found, on the contrary, to be *parallel* to that plane, as Mac Cullagh himself had supposed.

" He was enabled also from the same theory to deduce again, in a far easier manner, all the beautiful geometrical laws of crystalline reflection and refraction, which he had formerly laid before the Royal Irish Academy in 1837, and for which that body awarded him the honorary distinction of the Conyngham Medal, which I have before alluded to. And they fully confirmed the acute prophecy then made by his sagacious mind, on finding to his astonishment, that a law of reflection depended for its existence on the existence of a law of propagation; when he said that the law of vis viva which he had assumed at the outset could not be a fundamental, but rather a secondary law, and remarked that perhaps the next step in physical optics would be the deduction, as parts of one system, of all the laws, both of propagation and reflection, from some higher and more general law, containing them both as particular cases: anticipations which were singled out for special attention in the Address delivered by Sir W. Rowan Hamilton, on the occasion already referred to. How little, perhaps, did Professor Mac Cullagh then know that both of his own prophecies were destined to be so soon fulfilled, and both by the powers of his own mighty and creative mind!

" In the general case of total reflection at the surface of a crystal, he afterwards showed, by a most ingenious employment of imaginary quantities, that the refraction was still double, and never more than double; and he showed that the directions of the refracted rays remained always the same, whatever were the incidence, provided it gave total reflection. Again, as he had done for the case of ordinary reflection by means of his beautiful theorem of the polar plane, so in the case of total reflection he determined the two directions of polarization, in a given incident plane polarized wave, which would give uniradial refracted rays, by means not of a polar plane, but of a polar cylinder, which he succeeded in showing was the analogous surface in the more difficult case. And finally, by means of the circular sections of the ellipsoid apsidal to the surface of indices, he showed how to determine completely, in plane, position, and figure, the two ellipses of vibration corresponding to any given incident wave polarized in any azimuth, and incident at any angle greater than the angle of total reflection.

"In the particular case of total reflection at the surface of an *ordinary* medium, the whole theory of total reflection became exceedingly simple, and that case was left by him *completed.* He showed that whatever were the incidence, the refracted wave was always perpendicular to the intersection of the planes of incidence, and of the surface of the crystal. He showed that the axes of the ellipse of vibration projected on the plane of incidence, were parallel and perpendicular to that line, and the duration of vibration the same as in the general case. He gave a beautiful construction, by means of an equilateral hyperbola, touching with its vertex the section of the index sphere at the point where it intersects the same right line, for determining the velocity of the refracted wave, and the ratio of the axes of its elliptic vibrations corresponding to any given incidence. He determined the *limiting angle of total reflection.* And finally, he demonstrated the *two* empirical formulæ of Fresnel, for the *acceleration* of the refracted *phase* over the incident, and the subsequent *equal acceleration* of the reflected phase over the refracted; the one for the case of the incident light polarized *in* the plane of incidence, and the other for the same polarized in the perpendicular plane.

"For *all* cases, whether of propagation or of reflection, ordinary or total, the whole theory, as he has left it to us, is *analytically* complete; but the *geometrical* interpretations, in the general case of total reflection at the surface of a crystal, present very great difficulties. Many of these his acute intellect had, with great labour, surmounted; he had been working hard at the subject for the last six weeks of his life, and with so much success, that he had actually commenced a new paper for the Transactions of the Academy, embodying the results of his latest investigations."

But the services for which this Academy owes to Professor Mac Cullagh a debt of lasting gratitude, are not confined to his scientific labours and discoveries. His enlightened patriotism led him, even at the risk of diminishing his own fame, or at least of retarding his progress to celebrity, to publish his researches in Ireland, rather than avail himself of the many other means of publication that were open to him, and where his papers would have received a wider as well as a speedier circulation.

The same enlarged views enabled him also to appreciate the value of other branches of knowledge, which a man of less cultivated mind might be tempted to underrate, when viewed in the light of his own favourite and more dazzling studies. But it is to Mac Cullagh, to his splendid example of munificence, and to his untiring zeal, that we owe the creation of the spirit which led to the formation of our Museum of Antiquities, that has already attracted so much public attention, and which constitutes so important a feature in the present position of the Academy.

The Cross of Cong was the gift of Mac Cullagh to our national Museum, purchased at his own sole expense. On the 24th June, 1839, he presented it himself to the Academy, at a general meeting, and, after some remarks on its historical importance and value, he stated that his motive for presenting it to the Academy was "to save it from the shameful process of destruction to which everything venerable in Ireland has been exposed for centuries, and to contribute, at the same time, to the formation of a national collection, the want of which, he had been told, was regarded by Sir Walter Scott as a disgrace to a country so abounding in valuable remains. He trusted" (he said) "that the time was not far distant when that reproach would be no longer merited,—when the relics of antiquity, now scattered over the kingdom, would find their way to a place where they could be appreciated, studied, and preserved. He believed, indeed, that there already existed in the public mind a strong disposition in favour of such a plan, a disposition that only required to be awakened into action."*

He had himself the pleasure to see this anticipation realized, and to feel that he was greatly instrumental in awakening into action the disposition of which he then spoke. His spirit was immediately caught up by others, and the golden torques of Tara were purchased by a subscription, and deposited, with the Cross of Cong, in the Museum of the Academy.

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* Proceedings, Vol. I. p. 328.

Nor is this the only occasion on which Mac Cullagh showed his zeal in the cause of our national antiquities. More recently, when it was understood that the Domhnach Airgid was to be had,—a reliquary which Mr. Petrie had made known to us, and which contains the fragments of a manuscript copy of the Gospels, which may be regarded as of the fifth century,—Mac Cullagh again stepped forward, and paid down, from his own pocket, the sum of £300, in order to secure this interesting relic to the Academy, and to obviate the difficulty arising from the delay that must necessarily attend a public subscription. In this case, although his own contribution was a handsome one, yet he did not, of course, pay the whole cost of the purchase; but the zeal he exhibited was undoubtedly the means of securing the Domhnach for our Museum, and entitles him to the lasting gratitude of all lovers of our antiquities.

Of his private life and character it is unnecessary to speak in the presence of so many to whom he was intimately known, and by whom his virtues were fully appreciated. Quiet, unobtrusive, modest, unaffected, he was, perhaps the most entirely unselfish of human beings. His private charities were extensive, although known to but few; he was generous to a fault; and his readiness to assist the struggling and the poor often exposed him to the danger of being imposed upon. With the keenest relish for society, he was retired and almost ascetic in his private habits; and there was something in the purity of his character which commanded for him universal respect. No man living ever heard a light or ribald word from his lips; few, however hardened, would have ventured such a word in his presence. His religious opinions were strictly those of the Church to which he belonged, and were founded on the deepest and most cordial conviction, derived, in his case, not from acquiescence in the judgment of others, but from the fullest and most extensive examination of the subject for himself. This was, in fact, one of the most singular parts of his character, which can be best appreciated by those alone who were familiarly acquainted with him; for his horror of ostentation on such a subject carried him in general to the opposite extreme, and he observed on all religious questions an habitual reserve, which was only broken when an occasion presented itself of rebuking irreverence or refuting scepticism.

Of the fatal malady which preyed upon his spirit, and deprived society of one of its brightest ornaments, enough is already known to every one here. Severe mental application combined with other causes to produce the aggravated attack of dyspepsia, which, in the mysterious dispensations of Providence, was permitted to obtain the mastery over a mind of peculiar sensibility and refinement; and, on the 24th of October last he concluded his short but bright career.

The REV. ROBERT TRAIL fell a victim to the fatal dysentery, which he caught from his unceasing and indefatigable labours among the poor of the remote parish of Schull, of which he was rector; a district where the distress of the late disastrous season prevailed to an alarming excess, and where Dr. Trail's energetic exertions will long be remembered with gratitude by all classes of his parishioners. He was removed in the midst of usefulness, with the conviction that, although he perished himself in the attempt, his advice, his labour, and his purse, were, nevertheless, the means of saving the life and health of many of the poor around him. As a member of the world of letters, Dr. Trail was the author of some sermons and controversial works; but at the time of his death he was engaged in the laborious and elaborate work of translating and editing the works of Josephus, with illustrations of great beauty and elegance, which he had obtained at very great expense, from drawings made expressly for himself in the Holy Land.

The last on our list of lost members is one who must also be reckoned among the number of those who have suffered in this country from the effects of the late unparalleled season of disease and misery. Dr. CURRAN* was a native of the county of Down, having been born near Lisburn in the year 1819. In 1833 he entered the University of Glasgow, and in 1838 he was removed to the University of Dublin, where he took the first degree in medicine in 1843. Besides the laborious studies necessary for his Profession, to which he was devotedly attached, Dr. Curran found leisure for the successful study of modern languages; and in the University he was distinguished by his taste for the mathematical and philosophical sciences, and particularly for astronomy. Immediately after taking his degree he proceeded to Paris, for the purpose of attending the Parisian hospitals, and cultivating the acquaintance of the eminent medical men of that metropolis. He returned to Ireland after an absence of about a year, and in 1846 was elected a Licentiate of the College of Physicians in Dublin. His value was soon discovered by his professional brethren, and he was chosen immediately Professor of Medicine to the School of the Apothecaries' Hall, one of the Physicians to the Dublin General Dispensary, and Secretary to the Council of the Pathological Society. In 1846 he returned to the Continent, chiefly for the purpose of visiting the principal lunatic asylums there, and during his tour he became known to several of the medical societies of France, Belgium, and Holland, many of which conferred on him their honorary or corresponding diplomas.

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* A memoir of Dr. Curran, to which we are indebted for the facts here stated, has appeared in the Dublin Medical Journal.

Dr. Curran's writings were chiefly confined to some few articles in the periodical literature of his profession; which are, however, distinguished for their research and clearness of style.

In the latter end of the past summer, two medical gentlemen, M. Rodier and M. Henri Gueneau De Mussy, were sent over to Dublin by the French Government, to study the character of the epidemic here, and to inquire into the management of fever. M. De Mussy had previously been an acquaintance and friend of Dr. Curran, who became his guide through the pestilential abodes of the sick. M. De Mussy contracted a typhus fever of the worst description, during which Dr. Curran was his constant nurse and indefatigable attendant. He was soon himself also seized with the disease in its most fatal form; and, notwithstanding all the skill and aid of his professional brethren, he declined rapidly on the ninth day of the fever, and expired on Sunday morning, the 26th day of September last, in the twenty-eighth year of his age. Thus perished, in the prime of youth, and in the midst of the brightest prospects of professional celebrity, one of the most promising young physicians of Dublin; and a man whose benevolent, disinterested, and affectionate character in private life, had endeared him to all his friends.

The Report was ordered to be entered on the Minutes.

The Ballot for the Annual Election having closed, the scrutineers reported that the following gentlemen were elected Officers and Council for the ensuing year:

President.—Rev. Humphrey Lloyd, D. D.

Treasurer.—Robert Ball, Esq.

Secretary to the Academy.—Rev. James H. Todd, D. D.

Secretary to the Council.—Rev. Charles Graves, A. M.

Secretary of Foreign Correspondence.—Rev. Samuel Butcher, A. M.

Librarian.—Rev. William H. Drummond, D. D.

Clerk and Assistant Librarian.—Edward Clibborn.

Committee of Science.

Rev. Franc Sadleir, D. D., Provost; James Apjohn, M. D.; Robert Ball, Esq.; Sir Robert Kane, M. D.; George J. Allman, M. D.; Sir William R. Hamilton, LL. D.; Rev. Samuel Haughton, A. M.

Committee of Polite Literature.

The Archbishop of Dublin; Rev. William H. Drummond, D. D.; Rev. Charles W. Wall, D. D.; John Anster, LL. D.; Rev. Charles Graves, A. M.; Rev. Samuel Butcher, A. M.; Rev. James Wilson, D. D.

Committee of Antiquities.

George Petrie, LL. D., R. H. A.; Rev. James H. Todd, D. D.; J. Huband Smith, A. M.; Captain Larcom, R. E.; William R. Wilde, M. D.; F. W. Burton, Esq.; Samuel Ferguson, Esq.

The President then appointed, under his hand and seal, the following Vice-Presidents:

Sir William R. Hamilton, LL. D.; Rev. Franc Sadleir, D. D., Provost, Trinity College; Rev. Charles W. Wall, D. D.; and His Grace the Archbishop of Dublin.

His Grace the Archbishop of Dublin mentioned the fact that tar was found to be an effectual preservative against the Potatoe disease, provided the potatoes intended for seed be previously dipped in tar slightly warmed.

The Rev. Dr. Robinson gave an account of the present condition of the Earl of Rosse's great telescope, and detailed some observations made with it during a recent visit to Parsonstown.

In 1845 he had laid before the Academy the results obtained by Sir James South and himself, at the first trials of that magnificent instrument. The most remarkable of them had reference to what has been called the Nebular Hypothesis, in which it is supposed that nebulous matter forms suns and planets by its gradual condensation. Above fifty nebulæ, selected from Sir John Herschel's catalogue, without any limitation of choice but their brightness, were *all resolved without exception*. From this he conceives himself authorized to ask, is there any evidence that nebulous matter has real existence?

The appearances which were supposed to indicate the gradual condensation of this imaginary fluid, namely, an increase of brightness towards the centre (sometimes almost looking like a star surrounded by a faint atmosphere), were shown to be caused by a peculiar construction of the systems in which they had been found. This the telescope demonstrated to consist of a céntral cluster, mostly globular, of comparatively large stars, surrounded by an exterior mass of much smaller and fainter stars, whose arrangement is often circular and thin like a disc. When seen obliquely, they seem like long oval or pointed rays; and in this case, from the optical condensation of their component stellar points, the resolution is more difficult, but even here it was invariably effected.

He has often been asked why this instrument had given no further results. They who put the question had but a tion or polar distance, to which the assistant will set the sliding weight at the same time that the telescope is set on an object. It has been ascertained by trial that the elasticity of the impelling band (100 feet long) is quite sufficient to equalize the intermitting movement of such a scapement.

In searching for known objects, there is, of course, occasional difficulty in finding them, from the small field of view of ordinary eye-glasses. This is remedied by a supplemental eye-piece of very wide field; a slide carries it, and the holder of the others, so that by a little shift one can be substituted for the other in an instant. The eye-piece is similar to one which Dr. Robinson had long since made for his own instrument. It consists of three lenses; and fulfils the three conditions of equal flexure of the pencils, achromatism, and flat field, while its distinctness is equal to a Huygenian of equal power. In this one the field-glass is six inches diameter; it magnifies 216 times with a field of *thirty-one* minutes; and though this will only bring into action forty-three inches of the mirror, yet even so its optical power is very great; and Dr. Robinson thinks the view of the moon in it the most magnificent spectacle he ever saw. A nebula is easily found in this wide field; and bringing it into the centre, the eye-slide is shifted, and it is viewed with the higher powers.

The micrometer also appears deserving of notice. Notwithstanding the prodigious light of the telescope, it was found that any illumination of wires extinguishes many of the fainter details in nebulæ. Lord Rosse, in drawing 51 Messier, used a very ingenious substitute, a screw whose threads were rubbed with phosphorus. Dr. Robinson had made experiments with a micrometer whose platina wires were faintly ignited by a voltaic current; he found, however, that the heated air produced tremors quite incompatible with the use of high magnifying powers. An experiment of Mr. Babinet, described in the Comptes Rendus, has suggested a contrivance which seems quite satisfactory. If light be admitted through the edge of a piece of parallel and pellucid glass, *it cannot escape through its faces*, because it is incident on them at an incidence greater than that of total reflection. Looking through the faces, therefore, the field of view is absolutely black, unless there be bubbles or striæ in the glass; but if a scale of any kind be engraved on either of them with a diamond, the light escapes through the cuts, and they appear luminous. The division are 6″, and the eye-piece has, of course, a position circle.

Dr. Robinson regrets that he had very few opportunities, while at Parsonstown, of using the telescope, in consequence of the unfavourable weather, and of the circumstances which have been stated. Most of them, too, occurred while the speculum was imperfect; yet some facts which he observed may be worth the notice of the Academy.

In the moon may be mentioned that the wide surface at the bottom of the Crater Albategnius is all strewed with minute blocks, not visible in the three feet with 500. The exterior of the mountain Aristillus is all hatched as it were with deep gullies radiating towards its centre; and he was able to confirm his former observations, that the bright streaks which radiate from some craters (Kepler in this case) are not raised above the surface.

Jupiter was several times seen. The dark brown belts presented, on February 20, a remarkable appearance; they were full of faint striæ running nearly parallel to them, and seemingly belonging to the brighter zones on each side. The colour of the belts is deepest at the centre, and gradually dies away towards the edge. This he regards as evidence that they are seen through an atmosphere of considerable depth and imperfect transparency. From this too, and from the fact that the polar regions present a similar though less intense shade, it is evident that the darker parts are the body of the planet, and the brighter its clouds.

Several nebulæ, in addition to those which were mentioned in Dr. Robinson's former communication, were examined. Of these, Nos. 505, 540, 668, and 988 of Herschel's catalogue are mere globular clusters: 65 and 66 Messier are of the other class, which he considers to be central clusters, surrounded by discs of smaller stars seen obliquely. The first, however, is less elliptic than in Herschel's fig. 53. 1 Messier was examined, but little addition can be made to Lord Rosse's description of its appearance in the three feet,* except that the "nebulosity" is all resolved, and "the resolvable filaments" consist of pretty large stars. There is, however, in the body of the cluster one so much larger than the rest, that it can hardly belong to their system.

The great nebula of Orion was completely resolved in those places which presented the mottled appearance, even in indifferent nights, and while the speculum was imperfect. On February 20, after it was in good order, a power of 470 showed the stars quite distinct there on a resolvable ground; and this clearly separated into smaller stars with 830, which the instrument bore with complete distinctness. This diffusion of so many knots of stars through a vast stratum of others much more minute is a most wonderful sight; and while looking at it he could not help speculating on the aspect which the heavens would present to an observer there. Yet, possibly, the Milky Way, if viewed from without, in the direction of Taurus, would exhibit something similar. The Magellanic Clouds, as described by Sir J. Herschel, are evidently analogous systems. On the same evening an eighth star was found in the trapezium, a seventh having been discovered on the 10th; the first near Herschel's α, and in the opposite direction from the sixth one detected by Sir James South's large achromatic, and more distant; the second near β. It is worth mentioning, as illustrative of the effect of previous knowledge on vision, that having ascertained the parts where the stars were most distinct, he was able to see them in the three feet with certainty; though in former years he had repeatedly scrutinized it for this very purpose in vain.*

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* Phil. Trans. 1844, p. 322.

Two remarkable exceptions to the general plan of nebular systems are afforded by 64 Messier, and h 464. In general the centre is occupied by a cluster of comparatively large stars, round which the others are grouped. But in the first of these (Herschel's fig. 27) there is a central vacancy looking absolutely black by contrast with the surrounding mass of stars. At its south and preceding *edge* are disposed, rather irregularly, a knot of about 100 larger stars, of which it is scarcely possible to doubt *that they had once formed the usual globular cluster in the vacancy*, and had been in some way displaced from it. The second is a fine planetary nebula *in* the splendid cluster 46 Messier. The stars of the latter are large and very brilliant, so that probably it is not very remote; but the other is a round disc, entirely composed of minute blue stars, without any condensation in the middle; and the singularity is, that it is not encroached on by the stars of 46 Messier. One very large one is near its edge; but evidently it would not be possible to describe a circle of equal diameter in any other part without including several. Are we to suppose that this is a case of mere optical connexion? The probability is very small, of a cluster such as 46 Messier (which is not common), and a large planetary nebula (which is very rare) coinciding; and if we combine with this the probability of a round cavity through one being exactly the size of, and in a line with the other, that probability will be evanescent. It seems, therefore, necessary to conclude, that both are parts of the same system, and possibly more examples of the kind may be found.

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* A recent notice mentions that Mr. Bond, of Harvard University, in the United States, has resolved parts of this nebula with a Munich achromatic similar to that of Pulkova. The climate and lower latitude would assist him in some degree; but Dr. Robinson thinks his success must be in a great measure due to that precise knowledge of the phenomenon, and of the points where it might be looked for, which is afforded by Dr. Nichol's work. He perceived the fifth and sixth stars of the trapezium, but saw nothing of the new pair. It must be remembered that, however sharply an achromatic may define objects whose light is intense, its illuminating power is far inferior to that of a large reflector. An object-glass of sixteen inches has not as much light as a *Newtonian* of twenty-one.

Two other clusters, 37 and 50 of Messier, besides their own marvellous beauty, interested Dr. Robinson on another ground; they are in the Milky Way, and, therefore, are seen on its stars, and at a place where its depth is nearly a maximum. Now, these stars were all of notable size and brightness, so that the telescope evidently penetrated far beyond their enter or limit. This seems to require a change in some of the reasonings in Struvè's admirable Etudes d'Astronomie Stellaire. The author, among other curious matter, by applying the theory of probabilities to the numbers of stars of each magnitude in Argelander's Catalogue, and Sir W. Herschel's Star gauges, and by assuming that all stars are nearly equal, and that the Milky Way is unfathomable by telescopes in its greatest extension, finds this result, that the distance of the sixth magnitude is about seven times that of the first, and that the smallest stars visible in the eighteen-inch reflector of Herschel are 25½ times as remote as the sixth magnitude. But this telescope should show stars at three times that distance, and hence he infers that the "heavenly space" is not perfectly transparent. It appears to Dr. Robinson that the last of these assumptions is inconsistent with the above-mentioned observation; and that the other is equally at variance with the arrangement so often referred to, in which the central stars are much larger than the exterior. It may also be added, that the *penetrating* power of a telescope does not depend on its light alone, for every one knows that a high magnifying power shows small stars, which are invisible in the same telescope with a lower one. The "sweeping power" was only 157, and though it was the best for finding nebulæ, it was much too low to give the utmost range of vision.

But far the most singular objects which he has seen are the nebulæ which exhibit a spiral arrangement. He re-examined 51 Messier, Herschel's fig. 25, in which Lord Rosse had first seen it, and fully verified it: he could not, however, satisfy himself that it was to be traced in the three feet. On the night of March 11 (the only fine one, by the way, which occurred during his stay), he found several others, of which, however, it is difficult to give an idea without drawings.* In 99 Messier the centre is a globular cluster, surrounded by spirals, in the brighter parts of which stars are seen with 470: these have the same direction as in Messier 51, namely, from *east to west*, in receding from the centre. But these are combined with traces of another system in a reverse direction. h 604 is also spiral, but without any other peculiarity. 97 Messier is a strange object. With the finding eye-piece it looks like a figure of 8 with a star at the intersection, but with 470 it is spiral with two centres. The principal one still looks like a star, but with 830 gives a suspicion that it is a very small cluster.† The spirals related to this have the same direction as the former; but the other centre, which also looks like a minute star, has a smaller set in the opposite direction. Lastly, h 731, his fig. 43, in which the stars seem larger than the preceding, but in which no central cluster was observed, has curved dark bands across it, looking so like the section of a turbinated shell as to induce a suspicion that this has a similar arrangement, but is seen edgewise.

On the dynamical condition of such systems it would at present be idle to speculate; it must evidently be much more complicated than that of the ordinary globular clusters, which themselves are intricate enough. Their resemblance to bodies floating on a whirlpool is, of course, likely to set imagination at work, though the conditions of such a state are impossible there. A still more tempting hypothesis might rise from considering orbital motion in a resisting medium; but all such guesses are but blind. He believes it is Lord Rosse's purpose to make drawings of all these, *based on rigorous measurement*, which may serve as evidence of change hereafter, should such occur to any perceivable extent during the ages that are yet to come. The instrument will henceforward be regularly employed by an assistant, whom Dr. Robinson has trained for the task, and on whose zeal and steadiness he can rely; and as it cannot be turned to the sky without revealing something wonderful and glorious, he is certain that it will yield an unfailing treasure to science, that it will realize the high hopes of its generous master, and be one of the proudest distinctions of his country.

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* Drawings of M 51, M 99, M 97, and h 731, were exhibited.

† The next power is 1550, but it was impossible to use it effectually without a clock movement. This is also the case with single lenses, which are particularly effective on such objects.

April 10th, 1848.

REV. HUMPHREY LLOYD, D. D., President, in the Chair.

William Armstrong, Esq., Michael Barry, Esq., James Christopher Kenny, Esq., Rev. Joseph Fitzgerald, and Rev. William Graham, were elected Members of the Academy.

The Rev. R. V. Dixon made some remarks on the different conditions necessary to ensure a steam engine's working at "full pressure," and at "uniform pressure."

"A steam engine is said to work at 'full pressure' when the pressure of steam in the cylinder is equal to that in the boiler, or rather (as strict equality cannot exist while the machine is in motion) when the pressure of steam in the cylinder differs from that in the boiler only by a small fraction of the latter. In this case a relation exists between the velocity of the piston and the relative areas of the cylinder and steam pipe, which is easily determined. When the velocity of the engine is uniform we may assume that the pressures in the boiler and cylinder are constant, and are equal to P and P' respectively; at the same time also we shall have $av = a'v'$, a and a' being the areas of the cylinder and steam pipe, v and v' the velocities of the piston and of the steam issuing into the cylinder. Hence, the value of v'* being

$$v' = f\sqrt{\left(\frac{2g}{qw}\log\frac{n+qP}{n+qP'}\right)},$$

where f is a constant depending on the form of the steam pipe, we have

$$v = f\frac{a'}{a}\sqrt{\left(\frac{2g}{qw}\log\frac{n+qP}{n+qP'}\right)}. \qquad (1)$$

If the difference of pressures P, P' be small, we may assume that the densities vary as the pressures, which reduces (1) to

$$v = f\frac{a'}{a}\sqrt{\left(2k\log\frac{P'}{P}\right)}, \qquad (2)$$

in which $k = g \times$ the relative volume of steam under any pressure $\times$ the height of a column of water whose weight equals the same pressure.

"Further, putting $P' = P(1-n)$, n being a very small fraction whose square may be neglected, we have

$$v = f\frac{a'}{a}\sqrt{(2kn)}. \qquad (3)$$

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* This is the expression for the velocity with which an elastic fluid issues through a small orifice from a vessel in which the pressure is constant on a given section at a distance from the orifice, and equal to P, and at the orifice itself also constant and $= P'$, $g = 32{\cdot}15$ and $w =$ the weight of a cubic foot of water: the units of weight, space, and time, being the pound, foot, and second. The density is expressed in terms of the pressure by De Pambour's empiric formula, $d = n + qp$.

“ In order, then, that a steam engine should work with a pressure in the cylinder differing from that in the boiler only by the small fraction n of the latter, the velocity of the piston should not exceed the value determined for that particular engine by the equation (3).

“ Whatever the pressures in the boiler and cylinder may be, if the velocity, and therefore the pressures, be uniform, we must have the relation

$$va\,\frac{l'+c}{l} = \frac{S}{n+qP'}; \tag{4}$$

which is, in fact, a statement, in algebraic form, that the volume of cylinder open for the reception of steam during each unit of time is equal to the volume of steam under the pressure P', furnished by the quantity S of water evaporated in the same time, and is one of the fundamental equations of De Pambour's Theory of the Steam Engine.

“ If the engine is working at full pressure, as defined above, we may put P for P' in (4), and then

$$va\,\frac{l'+c}{l} = \frac{S}{n+qP}; \tag{5}$$

and substituting for P the greatest value (Π), which the boiler of a given engine will bear, we have for the lowest velocity at which it can work, without loss of steam, the equation

$$va\,\frac{l'+c}{l} = \frac{S}{n+q\Pi}. \tag{6}$$

For any velocity between the highest limit given by equation (3), and the lowest given by (6), the engine will work at ‘full pressure,’ and the value of the pressure corresponding will be given by equation (5).

“ The velocity of ‘full pressure,’ then, is not a *fixed* velocity, but in a given engine has assignable limits; a higher limit depending on the area of the steam pipe, and a lower, determined by the strength of the boiler.

"These obvious facts and inferences could not have escaped the notice of the Comte de Pambour, and accordingly, in his Treatise on Locomotive Engines, he has made some remarks on the connexion between the area of the steam pipe and the pressure of steam in the cylinder. In his Treatise on the Steam Engine, however,—the best, and, as far as I know, the only systematic work on the subject based on correct principles,—the author has not only omitted all reference to the effect of the magnitude of the steam pipe on the pressure of steam in the cylinder, but has made use of some expressions which might lead casual readers to form incorrect notions on this point. Thus, having determined that the maximum useful effect, with a given expansion, is obtained when the load of the engine is the greatest possible, and that this takes place when the pressure P' is greatest, he says:* 'The maximum useful effect will be given by the condition $P' = P$, or

$$v' = \frac{S}{a(n + qP)} \cdot \frac{l}{l' + c}.$$

This is, then, the velocity at which the engine must work, in order to obtain the greatest effect possible; and the equation $P' = P$ shows reciprocally that when this velocity takes place the steam enters the cylinder at full pressure, that is, nearly at the same pressure which it had when in the boiler.' And so also in his determination of the absolute maximum of useful effect,† he supposes $\frac{l'}{l}$ variable, but always connected with the velocity by the above equation; the velocity must, therefore, also vary, but as long as this equation is satisfied he considers the engine to work at 'full pressure.'

Now this equation is the same as equation (5) given above, and, as I have shown, is merely a statement that *if the velocity v' be within the limits assigned by equations* (3) *and* (6), the engine will work with uniform velocity, and at the full

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[*] Page 125, English edition.

[†] Pages 134, 135.

pressure P depending on this velocity and on the rate of expansion $\frac{l'}{l}$.

" It may be remarked, in conclusion, that for the completeness of the theory, and to show the connexion between all the variables of the problem, we should add equation (1) to the two given by the Comte de Pambour, and thus, between the four quantities, v, R, P', P, we will have, in the general case, the three following equations, leaving one of those quantities indeterminate.

$$\frac{l'}{l} + \frac{l'+c}{l} \log \frac{l+c}{l'+c} = \frac{n+qR}{n+qP'} \tag{A}$$

$$va\frac{l'+c}{l} = \frac{S}{n+qP'} \tag{B}$$

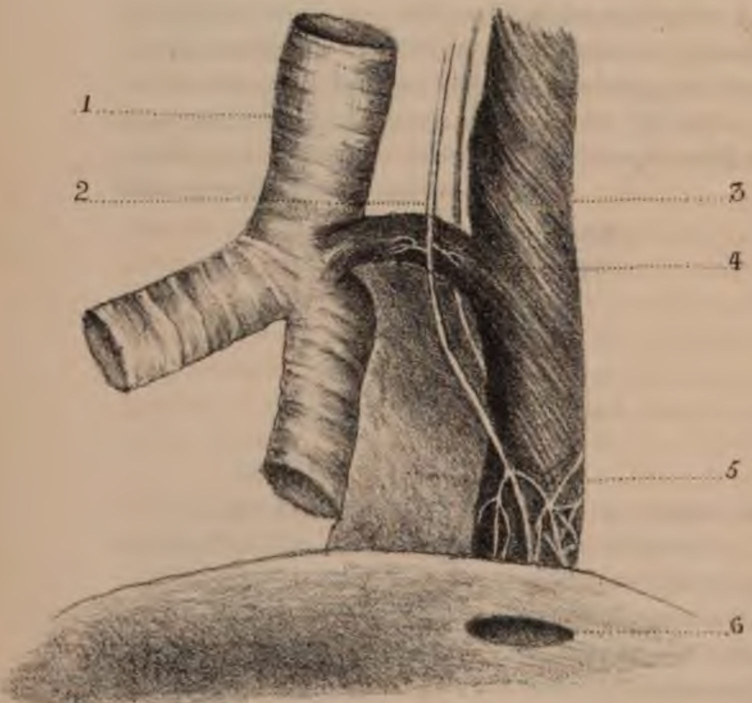
$$v = f\frac{a'}{a}\sqrt{\left(\frac{2g}{qw} \log \frac{n+qP}{n+qP'}\right)}. \tag{C}$$

Professor Harrison made the following remarks on the Larynx, Trachea, and Œsophagus of the Elephant:

" My principal object in the present communication is to direct attention to a particular muscle in the elephant, connecting the back of the trachea to the fore part of the œsophagus, and to which I would give the name of 'trachea-œsophageal muscle.' As I do not find any mention of this in Camper's works, or in the Encyclopedie Methodique, or in the article 'Pacchydermata,' by R. Jones, in Todd's Cyclopedia of Anatomy, I conclude it has not been observed by former anatomists.

" My attention was accidentally directed to it in the course of the dissection of the thoracic viscera. When removing the lungs and heart, I remarked an unusually close connexion to exist between the trachea and œsophagus, and which, on examination, I found depended on a short, thick muscle, which extended from the back part of the bifurcation of the trachea to the fore part of the œsophagus, and along which the fibres

Proceedings R.I.A. Vol. IV. p 133.



1. *Trachea, drawn over, so as to bring into view its posterior surface at the bifurcation*
2. *Pneumogastric nerves*
3. *Œsophagus*
4. *Trachea-Œsophageal Muscle*
5. *Elastic tissue connecting Trachea, bronchi, Œsophagus, and Trachea-Œsophageal Muscle, to the Diaphragm*
6. *Diaphragm*

[illegible]

descended to its lower or gastric extremity. The muscle was enveloped in that cellulo-elastic tissue which abounds in almost all parts of this animal, especially in the thorax, where it connects the lungs to the ribs and diaphragm (there being no pleural membranes), and extends from the latter along the œsophagus and trachea, connecting all parts intimately together. On dissecting through this tissue, the muscle in question was exposed: it may be described as an azygos muscle, placed horizontally in the median line, about two inches in its long axis,—that is from the trachea to the œsophagus, and about an inch in its vertical diameter; its anterior end arises from the posterior surface of the bifurcation of the trachea, by short tendinous fibres; these soon end in fleshy fasciculi, and form a thick, strong muscle, which passes backwards and bends a little downwards to the fore part of the œsophagus, along which the fibres descend, expand, and become continuous with its longitudinal and spiral fibres, and can be distinctly traced to the cardiac orifice of the stomach; the upper margin of the muscle is round, thick, and well defined; the lower margin is concave, and held in connexion with the diaphragm, and with its œsophageal opening, by the elastic tissue before mentioned. The pneumogastric nerves descend one along each side of this muscle, and give small branches to it. (See Plate).

"Imperfectly acquainted as we are with the habits and functions of this interesting group of the animal kingdom, in their natural state of liberty and of health, we cannot speak with confidence as to the design or use of this peculiar structure. We do know, however, that an intimate and a very peculiar connexion exists between the mechanical apparatuses concerned in the functions of respiration, of prehension of food, and of deglutition; and that the powerful and exquisitely organized proboscis is not merely a weapon of defence and of offence, but that it also serves as a breathing tube, and in a great measure as an instrument of voice; while at the same time it is the sole organ for the prehension of food, both solid and liquid. Viewing the attachments of this muscle, we may consider its power or action as twofold; first, supposing the trachea to be its fixed point, it might have some influence in raising the diaphragm, and thereby assisting in expiration; or it might raise the cardiac orifice of the stomach, and so aid this organ to regurgitate a portion of its contents into the œsophagus: as, however, we have no satisfactory evidence that this animal ever ruminates, it is useless to speculate on this supposed action of this muscle. Secondly, if we regard the œsophageal extremity of this muscle as the fixed point, and which we are entitled to do from its close connexion to the diaphragm and to the surrounding elastic tissue, it may then exert a twofold action on the trachea; first, it may dilate the thin and dilatable portion at its bifurcation, and thus assist in forming a reservoir of air previous to its forcible expulsion; or secondly, by depressing and fixing the trachea during the act of expiration, it may perhaps contribute to the more powerful expulsion of the air, by enabling the expiratory agents to act with concentrated energy on the lungs and on the air passages above, in those violent expiratory acts which the animal so frequently performs, as in blowing through the proboscis so as to produce loud trumpet-sounds, or in ejecting the water which he had previously drawn through it into the fauces, and which he is enabled to eject with extraordinary force,—sometimes upwards into the air, apparently for pleasure, sometimes at his enemy, in anger,—and frequently over different portions of his body, for the purpose of removing irritation from the skin, or for refreshing and cooling its surface, when exposed to a burning sun.

Although the elephant and horse are placed by naturalists in the one class, the 'Pacchydermata,' yet they differ materially in many parts of their organization, and in none more than in the anatomy of the larynx and trachea. The os hyoides and laryngeal cartilages are very large in the elephant, but possess little elasticity, a property eminently remarkable in those of the horse; in the latter, the epiglottis is very large, erect, elastic, and light-coloured; but in the elephant it is short and thick, with but little elasticity, and covered by a soft, pulpy, mucous membrane. The chordæ vocales are short and weak, the superior are wanting, and there are no ventricles or sacculi laryngis; whereas in the horse the chordæ are beautifully developed, the rima is narrow, and the ventricles are very capacious, and when distended bulge out between the fasciculi of the thyro-arytenoid muscles. In both animals the hyo-epiglotidean muscles are very large, but particularly so in the elephant; in the latter, the general laryngeal tube is very dilatable, but the rima is very deficient, and the contrary is the case in the horse. We may infer, therefore, that in the latter the function of voice essentially resides in the larynx, though modified by the passage of the air through the fauces and nares; whereas in the elephant the larynx would appear to have little effect on the air, in producing those varieties of tone so peculiar to this animal. In fact, the elephant may be said to have two distinct voices; one is the loud, monotonous roar, caused by the forcible passage of the air through the dilated larynx; the other consists of those piping trumpet-sounds, effected by the action of the numerous muscles of the proboscis on the air passing through this double tube.

"The trachea in the horse is eminently elastic, dilatable, and contractile; the extremities of the cartilages overlap each other, and the transverse muscular fibres pass beneath these, and are inserted into the cartilages a little behind their centre, so that a transverse section of the tube gives the appearance of its being divided into two, the anterior larger one for the passage of the air, the posterior smaller one occupied by reticular tissue. In the elephant the trachea possesses but little elasticity, the cartilages are nearly annular, and their extremities are connected by tough ligamentous tissue, in which I cannot discover any transverse muscular fibres."

Mr. Donovan read a paper on the Comparative Advantages of smelting Lead Ore by the Blast-hearth and the Reverberatory Furnace.

“Several methods are made use of in the docimastic art for reducing the ores of lead to the metallic state; one only is employed in the smelting-house, although there are some practical differences in the modes of carrying it into effect. The ore of lead which is most abundantly found and smelted in the British isles is galena, or sulphuret of lead; the object of the smelter is to deprive the ore of its sulphur, in order that the lead may be liberated in the metallic state. This object he effects by the conjoint action of heat and air. There are two methods of applying both,—by the reverberatory furnace and by the blast-hearth; and good judges are found to advocate the employment of each.

“A few years since I spent some time in Flintshire, amongst the smelting establishments, for the purpose of informing myself on the relative advantages of these two furnaces. I knew that in the north of England, and parts of Scotland, the blast-hearth is more in favour, and that it was the only furnace in use some years since in Yorkshire. In the whole extent of mining district, from Bagilt and Holywell to Mold and Halkin, there is not now one blast-hearth, none other save the reverberatory and slag-hearth being employed. In the memory of the present age there never had been a blast-hearth in Flintshire but one; and that, after having been used for some time, was abandoned. At Alston Moor, in Cumberland, the blast-hearth is still used, on account of the great length of land carriage of fuel.

“When the reverberatory furuace is to be employed, the ore, freed, as well as means permit, from extraneous matter and pulverized, is extensively spread out on the floor of th furnace, and exposed to the action of heat and a current of created by the draught of the chimney. Although the would bear any available temperature in close vessels, with parting with its sulphur, it cannot endure both heat and the current without desulphuration. The lead, therefore, separates in the metallic state; any foreign matter which the ore contained melts along with the lead, and swims upon its surface. This matter, called scoria, or slag, would run off with the lead when the furnace is tapped, but for a process of coagulation or thickening, which it is made to undergo by sprinkling lime upon its surface. The slag is finally removed, and melted with more lime in another furnace, called the slag-hearth, urged by bellows, and then it affords an additional quantity of lead. The first run is called soft, or ore lead; the second is hard, or slag lead, and bears a somewhat lower price.

"The blast-hearth is a small furnace, constructed of a few blocks of cast iron placed upon a bed of masonry, in such a manner as to include a square shallow well, in which is contained the burning fuel, consisting, according to circumstances, of wood, charcoal, common coal, coke, or turf, or all of these. A double bellows, of considerable size, worked by a water-wheel, or by manual labour, assisted by a heavy swinging pendulum, is made to blow a stream of air towards the centre of the fire, and being there obstructed by a burning sod of turf, placed for that purpose, the air is driven in all directions through the fuel; and thus is established an equal heat, as well as an equal blast, to carry off the sulphureous vapours through the chimney which surmounts the hearth. Lime, which ought to be very small in quantity, is occasionally thrown on to coagulate the slag; the melted lead trickles down to the well, which soon fills, and which ought to be allowed to remain full. New portions of lead will cause the well to overflow, and the melted metal will run down a gutter made in an attached inclined plane, called the apron, and thence into an iron pot placed beneath. The fire, after the charge has been smelted, is drawn out on the apron; the slags are picked out as soon as visible, and the fire is returned to its place with more fuel; the bellows is worked; more ore is thrown in; and this process, being continually repeated, constitutes the working of the blast-hearth. The slags, when enough has been collected, are transferred to the slag-hearth for a product of hard lead, as already described.

" In the blast-hearth, the current of air from the bellows, delivered in the centre, is made to circulate by the skill of the workman, and it is the test of a good smelter that he compels the blast to permeate the burning fuel equally in all parts, without overheating the furnace. No sulphureous fumes issue but for a short while after the fire has been roused and opened, and it is during this period that the lead runs; hence the process is slow. In the reverberatory furnace the current is voluminous and diffused; the sulphureous vapours are therefore carried off abundantly, and the lead is reduced with proportionate rapidity. Extent of exposure to the current even, in some degree, compensates deficiency of heat; and so much is this the case that lead ore spread out extensively in the sun's rays will, as I was assured by an eminent smelter, exhale fumes of sulphur, and consume less fuel in the subsequent smelting. It is in this very particular that the blast-hearth is deficient: a previous preparative desulphuration, in a small furnace, is practised in some places where the blast-hearth is used.

" The facility with which the slag is removed from the surface of the melted matter is a great recommendation of the reverberatory furnace: in the blast-hearth this can only be done by drawing out the fire on the iron apron, and letting it cool somewhat until the masses of slag can be seen in order to be picked out. The fuel is then returned into the well, and time is lost before it resumes its heat.

" In the blast-hearth, unless there be a horizontal flue, there is no small waste, by evaporation of both sulphuret of lead and of lead in the metallic state. But in the reverberatory both are detained in the horizontal flue and the high chimney or tower. The superintendent of an extensive mining locality assured me that an ore, which by assay was proved to contain 80 per cent. of metallic lead, would afford 74 per cent. in the reverberatory furnace, and only 64 per cent. in the blast-hearth.

"Notwithstanding this weight of evidence against the blast-hearth, it is not without its advantages. In inland situations, where land-carriage and consequent high price of fuel and other materials renders economy in these articles a countervailing consideration against the smaller produce of lead, the blast-hearth is a resource not to be contemned. When the supply of ore is not abundant, a reverberatory furnace would work to a great disadvantage: in such case the blast-hearth is, of course, to be preferred.

"There are some ores of so refractory a nature that the reverberatory furnace is very tardy in delivering its run of lead, although at length it gives such good produce: meanwhile expenses are accumulating. The ore raised from what in Flintshire is called a *blue stone*, which includes schist, mica-slate, and clay-slate, is much more refractory than what is raised from a white stone, that is, limestone: when raised from flint-stone the smelting becomes exceedingly difficult, and the quality of the lead produced is generally bad. In some such cases the blast-hearth has the advantage. A remarkable instance of this kind occurred at the Wheal-Betsy Mine, within five miles of Tavistock, in Devonshire. The ore obtained in that mine was refractory, and could with difficulty be smelted: the reverberatory furnace, in fact, might be said to have failed. The blast-hearth was then tried, and a produce, which corresponded much better with the assay, was obtained. The ore was, however, partially desulphurated in a small reverberatory, before it was transferred to the blast-hearth. Mr. Sadler says that two good smelters will smelt at the blast-hearth six bings of good ore a day, which are equal to about two tons eight cwt., short weight, that is, 5376 lbs.

"In the blast-hearth process a good deal of turf may be used in conjunction with coal, and this is a very great advantage in bog districts. The black turf of Ireland is capable of affording an intense heat, and may yet contribute to prove that our natural advantages are not of less account than those of other countries. The quantity of coal consumed in the blast-hearth is by much less than what is required for the reverberatory, and this is one of the chief recommendations of the former. Another is the very small comparative cost at which a compact smelting establishment may be constructed on the blast-hearth principle, and which, nevertheless, will be capable of doing a great deal of work. The long horizontal flue may be dispensed with; some lead in consequence will be lost, but no small outlay will be saved. Much space is also saved by the blast-hearth. There is a great advantage in smelting on the spot where the ore is raised: expense may, in certain localities, be saved, which would otherwise be incurred by the transport of the ore to one of the great smelting establishments. The mine proprietor will thus have a twofold source of profit. It is not possible to come to any positive conclusions on the comparative advantages of the two furnaces without taking into account local circumstances; it were an attempt to compare things that are not comparable. There is a trite saying amongst smelters that 'the blast-hearth saves coal and wastes lead;' and although this is true, yet, as Bishop Watson observes, 'a great quantity of metal, extracted at a great expense, may not produce so much clear profit as a less quantity procured at an easier rate: there is a beneficial limit between the quantity to be obtained and the expense attending the operation, which nothing but experience can ascertain.'

"On an occasion when it was necessary for me to come to a conclusion on the subject of this comparison, I made experiments intended to ascertain the quantity of lead producible from a given weight of ore, and also the cost of its production. The experiments were made with every precaution I could think of to insure accuracy, and I watched every step of the process, in order to avoid all sources of mistake or uncertainty.

" Two ores of lead, both of them galenas, but very different in their qualities, are found in the valley of Glenmalure, in the county of Wicklow; one a steel-grained, hard kind, very refractory in the fire, taken out of an exceedingly hard quartz; the other of a softer nature, more easily reducible to the metallic state, and either plumose or cubical in its fracture. I shall distinguish these varieties by the names of hard and soft ores.

" A heap of hard ore, weighing one ton, was exceedingly well mixed with the shovel. A heap of soft ore, also weighing a ton, was equally well mixed, and kept separate from the former. These were intended to be separately smelted. The blast-hearth being filled with its proper fuel, and now at a sufficient heat, ore not taken from either of the heaps intended for the experiment was occasionally thrown on the fire, and worked in the usual manner, until the well of the furnace was filled with melted lead, and began to run down the gutter of the apron, or, in technical language, until we had a *running sump*. Without this precaution, whatever lead would be procured in the subsequent smelting process might be attributed to the greater or less overflow of the sump, owing to greater or less pressure of fuel on the surface of the melted metal. This method was further corrected by ascertaining the number of inches which the lead fell in the sump, in each case, after the fire had been removed from its surface at night. Those who are conversant with smelting operations will readily understand me. The height and quantity of the superincumbent fuel pressing on the surface of the melted lead, at the moment when the sump began to run, was accurately observed; so that by leaving off with the same quantity of fire, the weight pressing on the melted lead was the same as at the commencement of the process, and thus no part of the lead produced could be attributed to an undue overflow of the sump. Care was also taken to exhaust the fuel burning in the hearth of all the lead furnished by the ore employed for producing a running sump, before any of the ore to be experimented on was thrown into the fire; and the same caution was observed in exhausting the fuel of its lead at the conclusion of each experiment. The fire left at the end of one process was used as fuel at the beginning of the next.

"All these preliminaries being arranged, and a running sump established, ore from one of the heaps was thrown on the fire at intervals; lime was occasionally sprinkled on to thicken the slag; and the smelting was continued in the usual manner, with a good blast, well circulated, until the whole ton had passed through the furnace, and the first run obtained.

"The slags were then transferred to the slag-hearth, and again smelted. The second slags were neglected, although in the great smelting-houses they are ground in a crushing-mill and buddled, and lead in grains is obtained in remunerating quantity. I had not means at my disposal for doing this, and hence my produce appears to a slight disadvantage. The ashes with which the slag-hearth had been filled were buddled, and some lead in small lumps procured. Both heaps of ore, viz., the soft and the hard, were subjected to the same treatment, and their lead extracted.

"I now proceed to state the cost of smelting one ton (of 2240 lbs.) of refractory ore, cut from a hard rock, laid down at the blast-hearth.

	s.	*d.*
Coals, carriage included (2 cwt.), ...	3	0
Coke, &c., ...	2	1
Lime (2 cwt.), ...	2	0
Turf (156 sods), ...	0	7½
Wages of ore-smelter, at 13*s.* per ton of lead,	6	7
Wages of slag-smelter, at 70*s.* per ton of lead,	2	6
	16	9½

This is the first cost of materials and wages for producing

	cwts.	qrs.	lbs.
Ore-lead, ...	10	0	22
Slag-lead, ...	0	2	24
	11	1	4

Cost of smelting one ton of soft ore cut from a soft rock:

	s.	d.
Coals (1¼ cwt.), ...	1	10½
Coke, ...	2	0
Lime (1 cwt.), ...	1	0
Turf (123 sods), ...	0	6
Wages of smelter, at 12*s*. per ton of lead, .	7	5
Wages of slag-smelter, at 70*s*. per ton of lead,	2	0
	14	9½

This is the first cost of materials and wages for producing

	Cwts.	qrs.	lbs.
Ore-lead, ...	12	1	3
Slag-lead, ...	0	2	5
	12	3	8

" The whole of the produce may be commercially considered as ore-lead; for the smelter is allowed to send to market one-tenth of slag-lead, yet it will all rate as ore-lead.

" For the sake of distinguishing the results, I caused the two heaps of ore to be smelted separately. Had they been smelted together in a state of mixture it is well known that the produce would have been greater, and at a less cost, as one ore acts a flux to another; and in the great smelting establishments the practice is to mix the different qualities. The arithmetical mean of my two results is 12 cwt. 12 lbs. of lead from one ton of mixed ore: but we may take it at least 12½ cwt., or 62½ per cent., had they been smelted together, at a cost of 15*s*. per ton of mixed ore. Hence, to produce one ton of pig-lead, 32 cwt. of ore should have been smelted, which would have cost, for materials and wages, 24*s*. If we assume the price of the mixed ore at £10 per ton, the cost of 32 cwt., with that of smelting it, will be £17 4*s*., and the produce one ton of pig-lead.

" We have now to consider what would be the produce of this ore had it been smelted in the reverberatory; and first, it is necessary to refer to its assay. The assay masters adopt different methods: sometimes they use fluxes; sometimes they dry the ore; but the most usual practice, and that most relied on by the smelters, who purchase on the faith of the assay, is to test the ore in the same moist state in which it is brought direct from the heaps, and without any flux, in order that the assay process may more nearly represent the process of the smelter. I therefore adopted this last method. Ten ounces of the mixed ore were melted in an iron crucible, and treated in the usual manner. In this process, all the sulphur that the conjoint action of heat and air is inadequate to expel, was abstracted by the affinity of the iron of which the crucible is made, and on this account a new crucible answers best. The button of reduced lead weighed 7 oz. 11 dwts., or very nearly. This would indicate 75 per cent. of metal, but as the assay produce is never realized by the reverberatory, the actual return would be about 70 per cent. of lead; and 71 per cent. was the average produce at a great smelting-house in Wales, from ores amounting in the aggregate to 36,000 tons. At another house the average was 75 per cent. Other trials returned 67.5 per cent., and sometimes only 50. According to Bishop Watson, the Derbyshire smelting-houses averaged but 67 per cent. It is probably about the truth to assume that the ores on which I experimented would have returned 70 per cent. in the reverberatory.

" At this rate, in order to produce one ton of pig-lead, it would be necessary to smelt 28½ cwt. of ore, which, at £10 per ton, would be £14 5*s*. The cost of smelting in Flintshire, by the reverberatory, may be averaged at 30*s*. per ton

(2400 lbs.) of ore; hence the cost of smelting 28½ cwt. would be £2, and the expense of producing one ton of pig-lead by the reverberatory would be £16 5*s.* The comparison stands thus:—

	£	*s.*	*d.*
One ton of pig-lead obtained by the blast-hearth would cost	17	4	0
One ton of pig-lead obtained by the reverberatory	16	5	0
	0	19	0

"According to this calculation, other things being alike, pig-lead obtained by the blast-hearth would cost 19*s.* per ton more than the same lead obtained by the reverberatory furnace. Such, at least, is the result of my trials. But in Mr. Sadler's account of lead-smelting he states that 'two men will smelt about six *bings* (5376 lbs.) of good ore a day, and from thence produce 24 pigs of lead, each weighing 154 lbs.;' that is, 68·7 per cent. If this estimate be admitted, in order to produce one ton of pig-lead we must smelt 29⅓ cwt. of ore, which, at £10 per ton, would cost £14 17*s.* 6*d.*; its smelting, by the reverberatory, £2 4*s.* 3*d.*; and the expense of producing one ton of pig-lead would be £17 0*s.* 7*d.* The comparison would then stand thus:

	£	*s.*	*d.*
One ton of pig-lead, by the blast-hearth, would cost, ...	17	0	7
One ton of pig-lead, by the reverberatory, . .	16	5	0
	0	15	7

"Thus the balance against the blast-hearth would be 3*s.* 5*d.* per ton of lead less than in my estimate. It is, therefore, a true aphorism that the blast-hearth saves coal and wastes lead. But we must place to its credit several advantages. The comparatively small cost of a blast-hearth, which would do all the work of a small mining concern, is to be considered; any small house, with a good chimney, can be made to answer: I have known smelting, by the blast-hearth, to a large amount, to be carried on in one of the streets of Dublin. We must also remember that, by smelting on the spot where the ore is raised, much expense is saved in the carriage of materials and produce. And it is a fact that some refractory ores are more easily smelted in the blast-hearth than in the reverberatory. On the whole, there is little use in endeavouring to come to a determination of the comparative merits of these two furnaces, in the abstract, without reference to the locality. The decision of the question must depend on the circumstances of the place; sometimes one furnace will be preferable, sometimes the other.

"I can adduce a case in point of the advantageous employment of a blast-hearth at a mine where the reverberatory furnace could not be maintained for want of a sufficient supply of ore, and the only alternative was exportation. When the Glenmalure lead mine (County Wicklow) was in brisk operation some years since, the following were the estimates of smelting on the spot, and exporting it to the nearest market:—

	£	s.	d.
Cutting out the ore from the rock, per ton, . .	3	17	6
Royalty (as it should have been), ...	1	10	0
Dressing, ...	0	16	0
Smelting, by the blast-hearth, ...	0	17	9
	7	1	3

"The produce was 12 cwt. 3 qrs. 8 lbs. of pig-lead; its carriage to Dublin, 13*s.* 8*d.*, added, made its cost £7 14*s.* 11*d.* in Dublin; but there it was sold for £9 12*s.* 4*d.*, leaving a profit of £1 17*s.* 5*d.* per ton of ore. Had the same ore been exported to Dee-bank, the additional charge of carriage to Wicklow, storage, freight, insurance, two commissions, and an assay, would increase the first cost of the ore to £7 6*s.* 4*d.*, while the price obtainable at Dee-bank was but £8 17*s.* 6*d.*;

the profit would therefore be £1 11*s.* 2*d.*, leaving a balance in favour of smelting the ore by the blast-hearth of 6*s.* 3*d.* per ton of ore, or an increased profit of nearly 17 per cent. If Mr. Sadler's estimate be adopted, the balance would be three times this sum.

"On the whole, I think it fair to conclude that the reverberatory furnace makes larger returns of lead; that where the produce of ore is inadequate to the supply of a reverberatory furnace, or where the cost or carriage of fuel and other materials is high, the blast-hearth is not without its advantages; that it is in vain to inquire, in the abstract, which is the more profitable furnace, as the decision of the question entirely depends on the circumstances of the locality."

April 24th, 1848.

REV. HUMPHREY LLOYD, D. D., PRESIDENT, in the Chair.

THE Rev. Charles Graves made a communication respecting Mathematical Expressions for Hypothetical and Disjunctive Propositions.

Adopting the principles and notation furnished by Mr. Boole in his "Application of Analysis to Logic," Mr. Graves suggests that it would be more in accordance with the ordinary use of language to express the hypothetical proposition,

If X be true, Y is true,

by the equation

$$x = vy, \qquad (1)$$

than by that which Mr. Boole has employed, viz.

$$x(1-y) = 0. \qquad (2)$$

In the former of these equations the symbol x selects all the cases in which the antecedent X is true, whilst y selects those in which the consequent Y is true; and v denotes an indeterminate symbol of election. The verbal enunciation, therefore, of equation (1) is, that *all the cases of the truth of X are included amongst cases of the truth of Y:* a statement which resembles the proposition,—If X be true, Y is true,—more nearly than the verbal interpretation of equation (2), which asserts that *there are no cases of the truth of X included amongst cases of the falsehood of Y.*

It is interesting to observe how readily the ordinary rules for hypotheticals flow as mathematical consequences from equation (1), regarded merely as an equation between commutative and distributive symbols.

1. If $y = 0$, $x = 0$.
2. If $x = 0$, it does not follow that $y = 0$.
3. If x be not $= 0$, y is not $= 0$.
4. If y be not $= 0$, it does not follow that x is not $= 0$.

These mathematical results being interpreted, give the following well-known rules:

1. If the consequent be false, the antecedent must be false.
2. The falsehood of the antecedent does not prove the falsehood of the consequent.
3. If the antecedent be true, the consequent must be true.
4. The truth of the consequent does not prove the truth of the antecedent.

The following example, treated by Mr. Boole in his book, p. 57, illustrates the use of the form here proposed for the equations of hypothetical propositions.

If X be true, either Y is true or Z is true.
But Y is not true.
Therefore, if X be true, Z is true.

The foregoing argument is succinctly expressed by means of the following equations:

$$x = v\,(y + z + yz)$$
$$y = 0$$
$$x = vz.$$

The immediate verbal interpretation of the first of which is, that *the cases in which X is true* (x) *are found by taking* (=) *the aggregate of all the cases in which Y and Z are separately and simultaneously true* ($y+z+yz$), *and selecting from this aggregate according to some law of election* (v), *the nature of which is not defined in the proposition.*

Mr. Graves added, that he had the satisfaction of learning that his suggestion, with respect to the mathematical expression of hypothetical propositions, had met with Mr. Boole's approval. In fact that gentleman had himself contemplated making the change here proposed, in pursuance of a like hint thrown out by Mr. Graves in the case of Categoricals.

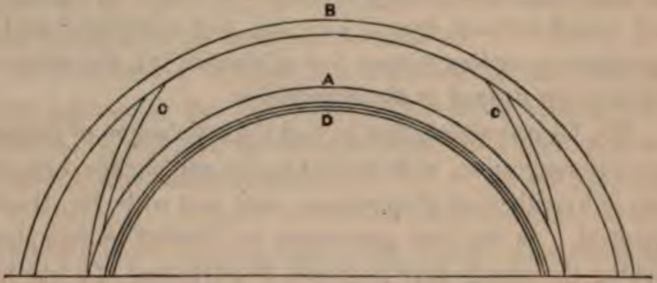
Rev. Dr. Todd read the following extract from a letter addressed to Dr. Apjohn, from Robert R. Cornwall, Esq., of Killucan:

"In digging round a rock in one of my fields, for the purpose of having it blasted, four very old graves were found; the bodies had evidently no coffins, but were surrounded on three sides by common, rough, flat stones, set upright on the edge. The rock answered for the headstone. The graves were but three feet long, twenty-two inches wide, and little more than two feet from the bottom of the grave to the grass. The bones very much decayed and broken; the top of one skull, and the face of another, were all that I could get in any way sound."

The President read the following communication from Mr. Stewart Blacker, upon an extraordinary Rainbow observed by him on the 7th of March in the north of Ireland:

" *Carrick Blacker, Portadown, Co. Armagh,*
" *March* 7, 1848.

" My dear President,—I have just observed a curious rainbow, which presented the following appearance, and think a note of the occurrence may be interesting to you.



" In the rough diagram I have sketched, A represents the primary rainbow; B the secondary; CC two spurs, or portions of another bow, shooting off from the two ground ends of the primary bow, and joining the secondary; DD two minor bows, composed of the violet colour only.

" In the two spurs the order of colours was the same as in the primary bow, and not reversed, as in the secondary. The whole was relieved against a dark, eastern sky, and very vivid and intensely bright in colour, and perfect in form. The hour, about a quarter to 5 o'clock, and the sun nearly setting, with a smart, passing shower. Of all the rainbows I have ever seen, none appeared *so close* to me.

" Very truly your's,
" Stewart Blacker."

In a subsequent letter Mr. Blacker writes :

" Between the bow and the sun (which, as I observed before, was very bright, and near setting) was the River Ban, swelled by the winter rains into a large lake.

" Do you think the triple rainbow could possibly be accounted for by supposing the sun's rays reflected from the expansive river, and thus striking the drops of rain in another direction? The river was in a perfect blaze of reflected light, like a mirror, at the time; in fact, less endurable by the eye than the luminary itself."

The President observed, that the explanation suggested by Mr. Blacker for this somewhat unusual phenomenon was undoubtedly the correct one. In fact, the *axis of vision*, as it is called,—or the axis of the cone of rays which form the bow,—is, in this case, the line drawn from the eye of the spectator in the direction of the sun's *reflected* rays; and accordingly the centre of the arch is a point as much *above* the horizon, as the centre of the original bow is *below* it. The phenomenon is manifestly the same as if the portion of the circle of the original bow, which is *below* the horizon, were turned upwards. The arch of the extraordinary, and that of the original bow, therefore, together form a complete circle; the former exceeding a semicircle as much as the latter falls short of it.

The President stated, that he had found two accounts of a similar phenomenon in the early volumes of the Philosophical Transactions: one observed by Halley in 1698, on the banks of the River Dee; and the other by Mr. Sturges in 1792, on the south coast of England. It is strange that it should not have been more frequently noticed, seeing that the only condition of its appearance (in addition to the ordinary conditions of the common bow) is the presence of a reflecting surface—such as the sea or a river.

James Pim, Jun., Esq., mentioned a remarkable aurora seen by him on the 19th of last month, in connexion with the obscuration of the moon.

May 8th, 1848.

REV. HUMPHREY LLOYD, D. D., PRESIDENT, in the Chair.

Sir Robert Kane read the following account, by the Rev. Professor Callan, of Maynooth, on the use and construction of a new form of the Galvanic Battery :

" In a paper published in the August Number of the London Philosophical Magazine, I described several experiments, which clearly prove that, as a negative element of the nitric acid battery, lead coated with chloride of gold or platina, or with borax dissolved in dilute acid, is superior to platina, and that cast iron is fully as powerful as platina. I have since compared, in various ways, the power of a cast-iron battery with that of a Grove's of equal size. The cast iron was excited by a mixture consisting of about four parts of sulphuric acid, two of nitric acid, and two of nitre dissolved in water. The platina was excited by equal parts of concentrated nitric and sulphuric acid. The zinc plates of both batteries were excited by dilute sulphuric acid of the same strength. The cast-iron battery was considerably superior to Grove's, in its magnetic power, in its heating power, and in its power of producing decomposition. The magnetic effects of the two batteries were compared by means of a galvanometer and of a small magnetic machine. Grove's produced a deflection of 82°; the cast iron caused a deflection of 85°. When the voltaic currents of the two batteries were sent simultaneously in opposite directions through the helix of the galvanometer, the current from the cast-iron battery destroyed the deflection caused by Grove's, and produced an opposite deflection of 60°. In the magnetic machine the cast-iron battery produced fifty revolutions in a minute; Grove's produced only thirty-five in the same time.

" The superiority of the heating power of the cast-iron battery was shown by its fusing a steel wire, which Grove's only raised to a dull red heat. I have been told by persons who tried the two batteries, that they found the heating power of the cast-iron battery to be twice as great as that of Grove's.

"The decomposing powers of the two batteries were compared by the quantities of the mixed gases which they produced during the space of three minutes. The result clearly established the superiority of the cast-iron battery.

"I have tried various kinds of cast iron, and have found them all to possess nearly equal power. I have got cast iron plates containing oxide of chromium: they did not appear to have any advantage over common cast iron. Perhaps, by mixing with cast iron some of the more negative elements, an increase of power may be obtained.

"Soon after I had discovered the great electromotive power of platinized lead and cast iron, when excited by nitric or nitro-sulphuric acid, I proposed to the Trustees of the College to change our Wollaston batteries into a platinized lead or cast iron one. They readily authorized me to expend the sum required for the change. After weighing well the relative advantages of platinized lead and cast iron, I resolved on the latter, principally because I found that it did not require to be platinized. In one of our Wollaston batteries there were 300 zinc plates, each four inches square, and in the other twenty plates, each two feet square. In the two batteries the surface of the zinc plates was something more than 113 square feet; the copper surface was twice as great as the zinc surface. After mature reflection on the best form for the new battery, and on the most convenient size of the zinc plates, I resolved to get water-tight, cast-iron cells, rather than plates; to retain the 300 four-inch plates; and to divide the twenty large plates into 320 small ones, each six inches square. I therefore ordered 300 porous cells, each four and a half inches high, four and a half inches broad, and half an inch wide, for the four-inch plates; and 320 porous cells, each six and a half inches high, six and a half broad, and about an inch wide, for the six-inch plates. I also ordered 300 cast-iron, water-tight cells, each about four and one-eighth inches high, five inches broad, and an inch wide, to hold the small porous cells; and 320 cast-iron cells, each about six and one-eighth inches high, seven and a quarter broad, and one and three-quarters wide, to contain the large porous cells. The new battery then was to consist of 620 voltaic circles, in which the entire zinc surface would be 113 square feet, and the surface of cast iron would exceed 226 square feet; but on account of several disappointments I have been obliged to be content for the present with 577 voltaic circles, containing ninety-six square feet of zinc, and about 200 square feet of cast iron. In this battery, which was exhibited in the College on the 7th of the last month, there were 300 cast-iron, water-tight cells, each containing a porous cell and zinc plate four inches square; 110 cast-iron cells, each holding a porous cell and zinc plate six inches by four; and 177 cast-iron cells, each containing a porous cell and a zinc plate six inches square. The zinc plate of each circle was placed in a porous cell, and the latter in a cast-iron cell. The inside of each cast-iron cell was about a quarter of an inch wider than the exterior of its porous cell. Slips of sheet copper about an inch broad and two and a half inches long, were soldered to each cast-iron cell, and to each of the 320 six-inch zinc plates. The four-inch plates were already furnished with screws and nuts. Each iron cell was connected by a binding screw with the next zinc plate. The iron cells were kept in an upright position in nine wooden frames, which were placed on wooden supports nearly three feet high. The battery was charged by pouring into each cast-iron cell a mixture containing about twelve parts by measure of concentrated nitric acid, and eleven and a half parts of double rectified sulphuric acid; and by filling to the proper height each porous cell with dilute nitro-sulphuric acid, consisting of about five parts of sulphuric acid, two of nitric, and forty-five of water. In charging the entire battery we used about fourteen gallons of nitric and sixteen of sulphuric acid. I abstained from using the solution of nitre through an apprehension that it would cause the exciting mixture in the cast-iron cells to boil over. I know not whether this apprehension is well founded; but I know that when ten or more cells are employed, the exciting fluid in the cast-iron cells will soon boil over, and produce nitrous fumes, if it does not contain one quarter of its bulk of nitric acid.

"I have found by experiment that a cast-iron battery is about fifteen times as powerful as a Wollaston battery of the same size, and nearly as powerful and a half as Grove's. Hence our new cast-iron battery, in which there are ninety-six square feet of zinc, is equal in power to a Wollaston battery containing more than 1400 square feet of zinc, or more than 13,000 four-inch plates, and to a Grove's containing 140 square feet of platina. Now the battery made by order of Napoleon for the Polytechnic School, which was the largest zinc and copper battery ever constructed, contained only about 600 square feet of zinc; and the most powerful Grove's of which I have seen an account did not contain twenty square feet of platina. Hence the cast-iron battery belonging to the College is more than twice as powerful as the largest Wollaston, and seven times as powerful as the largest Grove's ever constructed.

"I shall now describe a few of the experiments which were made with our large cast-iron battery on the 7th of the last month. The first experiment consisted in passing the voltaic current through a very large turkey, which was instantly killed by the shock. The craw of the turkey was burst, and the hay and oats contained within it fell to the ground. In order to give the shock, a piece of tin-foil, about four inches square, was placed under each wing along the sides of the turkey, which were previously stripped of their feathers, and moistened with dilute acid. The tin-foil was kept in close contact with the skin by pressing the wings against the sides. The person who held the turkey had a very thick cloth between each hand and the wing, in order to save him from the shock. As soon as the wire from the zinc end of the battery was put in contact with the tin-foil under one wing, sparks were given by the tin-foil, and shocks received by the turkey, before the connexion was made between the negative end of the battery and the tin-foil under the other wing, although the negative and positive ends of the battery were on tables nearly three feet high, and three feet asunder.

" When a copper wire in connexion with the negative end was put in contact with a brass ring connected with the zinc end of the battery, a brilliant light was instantly produced. The copper wire was gradually separated from the brass ring until the arc of light was broken. The greatest length of the arc was about five inches. As soon as the connexion was made between the opposite ends of the battery by the copper wire, which was a quarter of an inch thick, and about five feet long, a loud noise was produced by the combustion of the solder which fastened some of the copper slips to the zinc plates. I immediately went to the part of the battery from which the noise proceeded, in order to try whether the connexion between the cast-iron cells and zinc plates was broken; I found one slip of copper detached from the zinc plate to which it had been soldered. There were probably others disconnected with their zinc plates, but I did not find them. The result of this experiment showed that the turkey conducted only a part of the current circulated by the battery, for the current which killed the turkey produced no combustion of the solder by which the copper slips were attached to the zinc plates.

" We next tried the ignition of charcoal points. We were not able to determine the length of the arc of light between them: for before Sir Robert Kane had time to separate them, they were burned away. The light was, of course, most brilliant: the charcoal scintillated like steel or iron. I never before observed these scintillations in the combustion of charcoal. Coke points were also ignited, and a most intense light produced; but during the experiments with the coke points the circuit was interrupted in consequence of the fracture of one of the porous cells, which caused the dilute and concentrated acids to mingle together, and, consequently, to boil over, until the porous and cast-iron cells were nearly emptied. Notwithstanding this interruption of the circuit, the arc of light between the coke points was about an inch long, and the heat of the flame deflagrated a file.

"I had arrangements made for a long series of experiments on the decomposing power of the voltaic current, and of voltaic heat, and on the illuminating power of the various kinds of voltaic light, but these experiments I was obliged to omit, through fatigue, exhaustion, and bad health. I have since tried the illuminating power of the light produced by the ignition of coke points; and for the gas microscope and polariscope have found it far superior to the oxyhydrogen lime light. With good coke points, abundant light for the microscope and polariscope may be obtained from a battery containing twenty-five cast-iron cells, and as many zinc plates, each two inches by four: if the coke be not very good, forty plates will be required. When an iron cell, two and a half inches wide and four inches high, is large enough to contain between it and the porous cell nearly a wine-glassful of the concentrated acids, the battery will work with undiminished power for about three hours without any additional acid. If the cell containing the zinc plates be small, it will be necessary to pour in a little dilute acid every half hour. I have got the lime light by igniting the mixed gases as they were produced by the decomposition of water, and throwing the flame on lime.

"*Maynooth College*,
"*April* 6, 1848."

Professor Harrison read a paper on the Anatomy of the "Lachrymal Apparatus" in the Elephant.

"In no part of the animal economy has more curious and interesting diversity been displayed than in the structure and arrangement of the several 'tutamina oculi,' which constitute the lachrymal and palpebral apparatus. In aquatic beings the surrounding element renders these appendages in general unnecessary, and therefore, among them they are almost universally dispensed with, although we occasionally meet with some part of them in a rudimentary form; thus among the Cephalopodous Mollusca, the Octopus has the voluntary power of drawing the skin over the front of the eye, and in other species it is continued over this organ. Among the Gasteropods, the well-known tentacles in the limax admit of the eyes being retracted within the cutaneous tube, like the inversion of the finger of a glove, and are thus protected from external injury.

"In Fish the lachrymal apparatus is wholly absent, and the palpebral most generally so; but in some the skin passes over the forepart of the eye, without forming any fold; in others, there are slight duplicatures, more like eye-brows than true palpebræ; many of the osseous fishes have a small vertical fold at each canthus which can form a partial covering, and in the Tetraodon Mola the eye can be completely covered by an eye-lid which has a circular aperture capable of being closed by a sphincter muscle, and opened by five radiating muscles attached to the bottom of the orbit. (*Cuvier's Anat. Comp.*, tom. ii. p. 434.)

"In the Reptilia both the lachrymal apparatus and the palpebræ are present, but very differently modified in the different classes. In Birds the whole arrangement is most complete, there being three palpebræ, a lachrymal apparatus, and the gland of Harder.

"In Mammalia there is great diversity in respect to these organs. In Man and Quadrumana the palpebræ are very perfect, also the secreting and excreting lachrymal apparatus, but there is no third eye-lid, although the fold of conjunctiva at the inner canthus, "plica semilunaris," is rudimental of it, and there is no Harderian gland. In quadrupeds the third lid is superadded; generally contains a cartilage, consistent and elastic; connected with this lid is the Harderian gland.

"I shall confine my observations, on the present occasion, to the condition of these organs in the elephant. This animal, it is well known, is furnished with a highly developed middle eye-lid, or "membrana nictitans," the anatomy of which, however, I do not find has been correctly or fully described by authors.

"Camper's account of it is (tom. ii. p. 137): 'The third eye-lid, very thick and fleshy, moves obliquely towards the external angle of the eye, as in Ruminants; the motion is directed by *two muscles*, not found in any other quadruped. The first, which serves to draw the membrane over the eye, is attached obliquely to the inferior edge of the orbit, at a considerable distance from the outer angle. The second muscle, which may be regarded as the antagonist to the former, retracts this organ towards the inner angle.'

"In the Encyclopedie Methodique, by Vicq d'Azyr and H. Cloquet (tom. iii. p. 187): 'The third eye-lid presents two strong muscles: the *elevator* penetrates deeply into the orbit, beneath the inferior oblique muscle, to be attached near the optic hole; the other muscle, destined to retract this membrane, fixes the anterior angle of the corresponding fibro-cartilage to the internal part of the circumference of the orbit.'

"In Todd's Cyclopedia of Anatomy, (Art. 'Pacchydermata,' p. 876, by R. Jones), the author observes: 'The third eye-lid is very largely developed in the elephant, and can be drawn over the eye-ball to a considerable distance towards the outer angle of the eye. It is provided with two by two muscles, the *quadratus*, which forms a loop or pulley, through which the long tendon of the *pyramidal* passes in its course to the membrane; by the joint action of these two muscles this curtain is drawn with great velocity over the cornea, while its elasticity again restores or retracts it to the inner canthus, the moment the muscles and the tendon are relaxed. In the elephant the same agencies, namely, two muscles and an opposing elastic force, are employed, though somewhat differently modified.

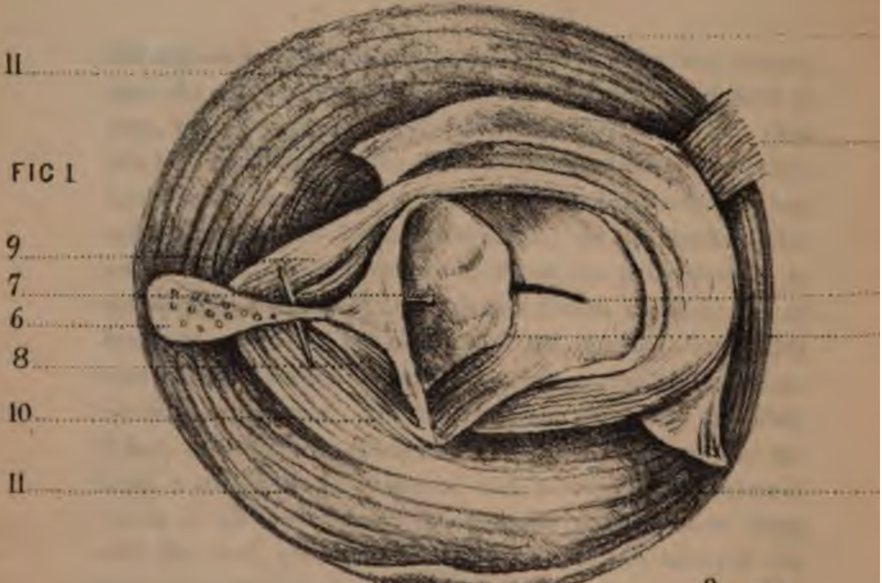
"I may here briefly advert to the middle eye-lid of the horse, one of the Pacchydermata: it consists of a true cartilage enclosed in a conjunctival fold, as in the elephant; it is, however, thinner and weaker, the pedicle is flat and thin, and imbedded in fat; this latter substance is collected into a large oval mass, surrounded by a fine but distinct capsule, which is connected to the adipose and cellular tissue in the orbit, and which possesses some elasticity: an expansion from the superior and internal recti muscles is also attached to it. The eye in this animal is furnished with a powerful 'retrahens or suspensorius muscle,' which extends from the optic foramen around the optic nerve, and is inserted into the sclerotic coat. When this muscle retracts the eye, the ball of fat slips forward, and the cartilage and conjunctival fold shoot forward and outward; the eye at the same time is adducted by the internal rectus, which also presses forward the fat ball and the nictitating cartilage, and thus a great portion of the cornea becomes covered or swept over by the third eye-lid, but never to the same extent as in the elephant, where there are the two proper nictitator muscles. In the latter, also, there is no retrahens muscle, but the long and slender optic nerve is surrounded only by cellulo-elastic tissue, which extends from the apex of the orbit to a considerable bulbous swelling around the entrance of the nerve into the eye; this bulb appears composed of fibrous, cellular, and venous tissues. The absence of this retrahens muscle in the elephant entails the necessity of a totally different mechanical arrangement for the third eye-lid, from that which exists in such a simple form in the horse.

"In the elephant the *gland of Harder* is very large, of an oval, flattened form, placed at the inner and anterior part of the orbit, and quite distinct from the surrounding adipose and cellular tissue; its duct, about an inch and a half long, runs parallel to the pedicle of the cartilage, and opens behind the root of the nictitating membrane by a distinct foramen, large enough to admit a common probe. The caruncula lachrymalis is also large, a proof that this body is not to be regarded in other animals as the analogue of Harder's gland, but rather as a part of the system of Meibomian or ciliary follicles. The true lachrymal apparatus is absent in the elephant; a few red granules or mucous glands beneath the conjunctiva in the superior external palpebral sinus alone indicate its usual site; there are no lachrymal puncta, ducts, or sac. The highly developed middle eye-lid, with the Harderian gland, supply the place of this apparatus. In the horse the lachrymal gland is present, also the puncta, ducts, and sac, but the Harderian gland is rather a follicular series entangled in the fat ball, and opening by several fine ducts on the ocular surface of the nictitating cartilage. In the bird the Harderian gland is very large and distinct, as also the lachrymal, and there is a slit-like passage for the secretions to flow into the nose.

"It is unnecessary here to allude to the temporal glands, which are peculiar to the elephant, as they have no connexion whatever with the palpebral apparatus; their secretion is probably odoriferous, and, like that of the larmiers or infraorbital sacs in the antelope species, has some connexion with the sexual functions.

"There is one peculiar feature in the anatomy of the orbit of the elephant, which I think worthy of demonstrating on the present occasion, though unconnected with the lachry-

FIG 1



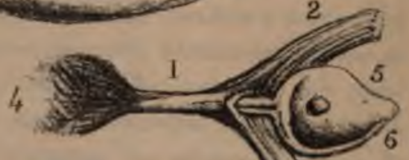


FIG 2

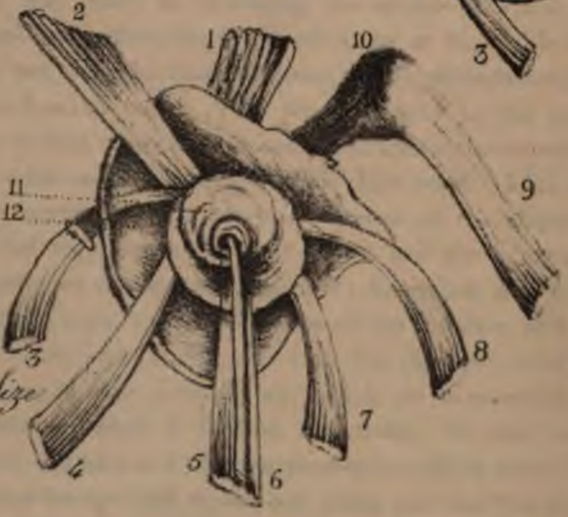


FIG 3

1/4 the nat. size

The Subjects that those drawings were taken from are preserved in the Anatomical Museum, Trinity College.

socket joint to the extremity of a long and flexible cervical spine, can rotate freely, and the animal can look around, and even see an object behind it, without changing the position of its body. Whoever has carefully observed the living elephant must have been struck with the peculiar expression of his small but clear and brilliant eye, moving freely in every direction; he glances at the spectator with a sort of suspicious scowl, views him steadily, observes and follows his motions merely by the rolling of his eye-ball, without any change in the position of his head or of his body."

EXPLANATION OF PLATE.

FIGURE I.—*View of the posterior or ocular surface of the eye-lids and memb. nictitans.* 1. Upper eye-lid; 2. Levator muscle of ditto; 3. Palpebral fissure; 4. Membrana nictitans, or third eye-lid; 5. Lower eye-lid; 6. Harder's gland; 7. Duct of ditto, opening on the ocular surface of the memb. nict.; 8. Nictitating cartilage; 9 and 10. Upper and lower nictitator muscles; 11. Orbicularis palpebrarum.

FIGURE II.—*Nictitating membrane, cartilage, and muscles, removed.* 1. Cartilage, its long pedicle; 2, 3. Superior and inferior nictitator muscles; 4. Elastic tissue attached to pedicle of cartilage; 5. Membrana nictitans, enclosing the thin expansion of the cartilage; 6. Opening of Harder's duct.

FIGURE III.—*Globe of the eye and muscles of the orbit.* 1. Levator palpebræ sup.; 2. Sup. rectus; 3. Sup. oblique; 4. Inter rectus; 5. Infer. rectus; 6. Optic nerve, long and slender; 7. Infer. oblique; 8. Exter. rectus; 9. Second exter. rectus, or retrahens orbitæ anguli externi, inserted into 10. Fibrous mass at the outer canthus of the orbit; 11. Globe of the eye; 12. Bulb surrounding the entrance of the optic nerve.

Sir Robert Kane presented, on behalf of the Hon. Skeffington Daly, a cinerary urn found near Athenry.

May 22, 1848.

REV. HUMPHREY LLOYD, D. D., President, in the Chair.

On the recommendation of the Council, it was

Resolved,—That the sum of fifty pounds be placed at the disposal of the Committee of Antiquities, for the purchase of articles for the Museum.

The Secretary presented, on behalf of Maurice O'Connell, Esq., two large bronze axe-heads, found, with nine others, near Derrynane Abbey. Also a bronze spear-head and gold ring, found at the cutting of turf in the island of Valencia, in June, 1837, within about four feet of the surface, and at a distance from one another of about three feet. The ring, when found, was as pure in the colour as when wrought, but the spear was covered with a greenish scurf. In the socket of the spear was a handle, of about five feet long, and of the substance of a common hand stick, which went to dust when stirred. Where they were found was within about forty perches of the harbour.

Mr. Maurice O'Connell communicated the following account of the discovery of the other antiquities presented by him to the Museum:

"The two bronze battle-axes were found about the year 1840, in the bed of the Carhen River, barony of Iveragh, and county of Kerry, within about two hundred yards of Carhen House, the birth-place of my father. By his directions works were being carried on to change, in some places, and confine in others, the course of the river, with the intention of taking in a considerable tract which was overflowed at high water. At one place the altered course was taken through a channel between a small "corcass" and the mainland. In the centre of this channel stood a large and apparently solid rock, which was used as a sort of stepping-stone in crossing into and from the corcass. This it was necessary to remove, in order to give a sufficient breadth to the channel. While some of the men were boring the upper part for blasting, a stander-by observed a small crevice in the side of the rock, into which he thrust a crow-bar, and, finding that he could move the upper part of the rock, which formed a kind of slab, he pointed it out to the other workmen. In a few minutes, by employing more crow-bars, they dislodged the upper slab. Underneath and in the middle of the lower portion of the rock a hollow space was found, in the centre whereof was a heap composed partly of ashes, partly of small bones; but arranged in a circle round the heap, with their broad edges outwards, were ten or eleven bronze axes of various sizes. Those I have presented are the largest and most remarkable. The bones generally crumbled into dust on being touched, but some portions were in a sufficiently sound state to bear removal. My father had these examined by a surgeon, who stated that they were not human bones but those of deer. The ashes were wood ashes. There is no tradition of any kind which can give a clue to the time or occasion of the placing of these axes, nor was there even the slightest suspicion of the existence of the kist in which they were found, as the rock externally appeared to be quite solid."

Edward J. Cooper, Esq., communicated the following letter from Mr. Graham, his principal assistant at the Markree Observatory, containing the Elements of the new Planet *Metis*, recently discovered by that gentleman.

"*Observatory*, 11*th May*, 1848 (*Noon*).

"SIR,—I have just obtained a first approximation to the elements of 'Metis.' The following observations were made the bases of the calculations:

G. M. T.		App. α	App. δ	
April	26·541140	223°52′36″·2	– 12°31′37″·9	Markree.
	30·569109	222 52 3 ·3	20 44 ·1	Reg. Park.
May	5·478479	221 37 44 ·7	7 44 ·9	Markree.

"The results are:

1848, April 30·0. (Greenwich mean time.)

Mean anomaly	129° 50′ 1″·79
Perihelion on orbit	75 38 4 ·45
Node	68 23 40 ·05
Inclination	6 36 31 ·08
Angle of eccentricity . . .	13 41 11 ·91
Log. semiaxis major . . .	0·3823490
Mean daily motion . . .	947″·2904

Time of Revolution, 1368 days.

"For the middle place this gives the differences (calculation minus observation) – 0″·03 in longitude, and – 0″·01 in latitude.

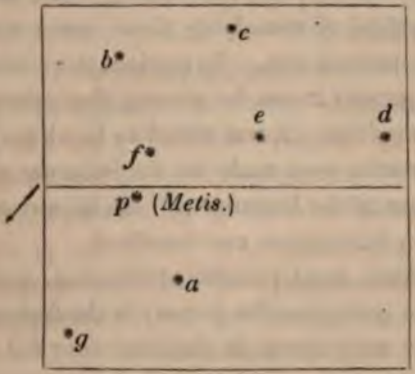
"Of course the result from so small an interval of time can only be regarded as a rough approximation. I only give the tenths and hundredths of seconds, as what I actually obtained, and as what I used in checking the result.

"Mr. Hind very opportunely and kindly sent me two observations which he made on April 30 and May 1. I was particularly desirous to get observations on those nights, but failed, on account of the weather. His observations seemed to agree admirably, and I had no hesitation in adopting one of them in my calculation. My own observations were taken with especial care, by both great Equatorial and Meridian Circle, on both nights. On the whole, I trust there is no material error in the elements as given above.

"I have the honour to be, Sir,
"Your very affectionate and humble Servant,
"A. GRAHAM.

"*Edward J. Cooper, Esq.*"

Sir William R. Hamilton handed in the following diagram, representing (rudely) the manner in which the planet Metis was seen on April 28, 1848, in an inverting telescope:



On April 30, 1848, the other seven stars, *a*, *b*, *c*, *d*, *e*, *f*, *g*, of this group, retained their respective positions; but the planet *Metis* had withdrawn from the position *p*, and had left the (circular) *field* indicated above, in the direction of the arrow.

The planet was thus seen at the Observatory of Trinity College, Dublin, in consequence of information from the discoverer, Mr. Graham, principal assistant to E. J. Cooper, Esq.

Mr. Donovan read a paper "On several Improvements in the Construction of the Galvanometer; on Galvanometers generally; and on a new Instrument for measuring and ascertaining the Distribution of Magnetism in Needles intended to be astatic, and for communicating to them greater sensibility."

The galvanometer, in the present day, has become a most important instrument of research, whether it be considered as a measure of electricity or of heat. In the latter capacity it exceeds all others in sensibility, and the promptness of its indications. But the construction at present in use is liable to the interference of circumstances which lessen its sensibility, and occasionally lead to errors of no small magnitude. The errors of construction were described by Mr. Donovan, and shown to be of such kind, that, in the attempt to preserve sensibility, we sacrifice it by introducing a new source of deception. A method of remedying these errors without such a sacrifice was pointed out. Exceptions were taken against the method at present in use for placing the galvanometer in the magnetic meridian; it was stated to be altogether inadequate; and remarks were made on the influence of this error on the indications of the instrument. An improvement in the galvanometer in this respect was described.

Galvanometers, as at present constructed, possess either too much or too little directive power: in the former case they are insensible to weak forces; in the latter they fail to indicate strong ones, because the maximum effect is produced by very feeble sources of power. The new galvanometer contains different provisions against these imperfections.

Several curious and important properties of the needle commonly called astatic were noticed; and some consequences highly detrimental to its proper action, and conducive to greater error in its indications, were fully described. A new instrument, called a *volta-magnetometer*, was exhibited, which detects and remedies these errors. A new method of magnetizing needles, and a new construction of needles, along with several observations on the defects of those at present in use, were introduced to the notice of the Academy.

Instruments exhibiting the defects of the present construction of galvanometers, as well as others in which these defects have been remedied, lay on the table during the reading of this paper.

The conclusion of the paper was as follows: "The improvements in the construction of galvanometers here suggested may be summed up as follows: 1. the addition of means, independent of the astatic needle, for setting the instrument in the magnetic meridian; 2. the close approximation of the needles to the coil; 3. the removal of obstructions to the rotation of the needles; 4. the means of inducing in the needles the least difference of polarity that is consistent with their function; 5. a method of detecting and preventing derangement of the needles, arising from forces which cause in them a tendency to stand transversely to their true position; 6. a construction of the needles which renders available the operation of a strong or a weak directive force, as may be required; 7. the introduction of a controlling graduated magnetic power for regulating the deflecting influence of voltaic forces on the needles.

"I venture to hope that those improvements, along with the several adjustments and facilities added, will render the instrument more convenient, will increase its sensibility, and contribute to the accuracy of its indications."

The President observed, that all the facts respecting the position of equilibrium of the astatic needle, to which Mr. Donovan had directed the attention of the Academy, and which (as far as he was aware) he has been the first to notice, were simple and immediate consequences of theoretical laws.

When two magnetic needles are united by a fixed vertical axis passing through their centres, and perpendicular to both, the moment of the force exerted by the earth upon them is the sum of the moments which it exerts upon each needle separately, and is, therefore,

$$X(M \sin u + M' \sin u');$$

in which M and M' denote the *magnetic moments* of the two needles, u and u' the angles which their *magnetic axes* make with the magnetic meridian, and X the horizontal component of the earth's magnetic force. In the state of equilibrium this moment is nothing; so that if u_0 and u_0' denote the corresponding values of u and u', there is

$$M \sin u_0 + M' \sin u_0' = 0. \qquad (1)$$

Consequently, if two lines be taken from any point of the vertical axis, parallel to the magnetic axes of the two needles, and proportional to their magnetic moments, M and M', the diagonal of the parallelogram constructed upon them must lie in the magnetic meridian, when the compound needle is at rest.

Again, if we substitute $u = u_0 + v$, $u' = u_0' + v$, in the general expression of the statical moment, it becomes, in virtue of (1),

$$X\,(M \cos u_0 + M' \cos u_0') \sin v.$$

Hence the compound needle is acted upon as a single needle, whose *magnetic axis* lies in the direction of the diagonal of the parallelogram above mentioned, and whose *magnetic moment* is

$$\mu = M \cos u_0 + M' \cos u_0'. \tag{2}$$

Accordingly, the diagonal of the parallelogram already referred to will represent in magnitude the magnetic moment of the compound needle. For, if the equations (1) and (2) be squared, and added together, and the angle contained by the magnetic axes of the two needles, $u_0' - u_0$, be denoted by a, we have

$$\mu^2 = M^2 + 2MM' \cos a + M'^2. \tag{3}$$

In the case of the *astatic* needle, $a = 180 - \delta$, δ being a very small angle, and $\cos a = -\cos \delta = -1 + \frac{1}{2}\delta^2$, *q.p.* whence

$$\mu^2 = (M - M')^2 + M M' \delta^2. \tag{4}$$

Accordingly, when $M - M'$ is not a very small quantity, the second term may be neglected in comparison with the first, and $\mu = M - M'$, nearly. On the other hand, when $M - M' = 0$, we have $\mu = M\delta$.

Returning to (1), and substituting for u_0' its value $u_0 + a$, we have

$$\tan u_0 = \frac{-\sin a}{\frac{M}{M'} + \cos a}; \tag{5}$$

by which the position of the needle with respect to the magnetic meridian, when at rest, is determined. In the case of the astatic needle the preceding equation becomes

$$\tan u_0 = \frac{-M'}{M - M'} \cdot \delta \sin 1'. \qquad (6)$$

From this we learn,

1. That the tangent of the angle of deviation of the astatic needle from the magnetic meridian varies, *cæteris paribus*, as the angle, δ, contained by the magnetic axes of the two component needles.

2. That however small that angle be, provided it be of finite magnitude, the tangent of the deviation may be rendered as great as we please, and therefore the deviation be made to approach to 90° as nearly as we please, by diminishing the difference of the moments of the two needles.

Sir W. R. Hamilton communicated the following double mode of generation of an ellipsoid, which had been suggested to him by his quaternion formulæ.

Conceive two equal spheres to *slide* within two cylinders, in such a manner that the right line joining their centres may remain parallel to a fixed line; then the locus of the varying circle in which the two spheres intersect each other will be an *ellipsoid*, inscribed at once in both the cylinders, so as to touch one cylinder along one ellipse of contact, and the other cylinder of revolution along another such ellipse.

And the *same* ellipsoid may also be generated as the locus of *another* varying circle, which shall be the intersection *of another pair of equal spheres*, sliding within the same pair of cylinders, but having their line of centres constantly parallel to another fixed line. Every ellipsoid can be generated by the above double mode of generation.

Professor Graves read the first part of a paper on the Ogham Character.

When the numerous Ogham inscriptions so liberally communicated to Mr. Graves by Captain Larcom and Dr. Petrie were subjected to the method of analysis, of which an account has been already given (p. 70), the first result obtained was the recognition of the group of vowels, *a*, *e*, *i*, *o*, *u*; which discover themselves by their superior readiness to combine with all the remaining letters of the alphabet.

Having been prepossessed with the notion that the key of the Ogham cipher, given in most Irish grammars, was not the true one, Mr. Graves was surprised to find that the five Ogham characters, which his method showed to be vowels, were the same as those to which the common key assigns these powers. He further noticed that among these five the characters most frequently recurring were the two which, according to the common key, stand for *a* and *i*, the very letters which a complete tabulation of all the Irish passages in the Book of Armagh had shown to be the letters of most frequent recurrence. Here was, at the outset, a decided indication of the correctness of the received key.

Again, the tabular analysis of the inscriptions manifested the frequent duplication of a frequently occurring character, hitherto supposed to stand for *q*; whilst the table founded on the Irish in the Book of Armagh pointed to *c* as the consonant most frequently recurring, and also most commonly doubled. This, so far from being a discrepancy, was taken to be another proof of agreement, since in ancient Irish MSS. the letters *c*, *k*, and *q* are constantly interchanged. For instance, the name of *Kiaran* is often found spelled with an initial *c* or *q*.

Another fact *immediately* manifested by the analysis of the inscriptions, was the occurrence on almost every monument of a group which, read according to the old key, would be *maqqi* or *maqi*. This was a fresh confirmation of the correctness of that mode of reading; the word "*son*" being obviously one likely to appear on inscribed monuments. Not to dwell on other less striking coincidences, it is enough to state, generally, that a comparison of the results obtained by tabulating the inscriptions and the Irish of the Book of Armagh, furnished conclusive evidence, both by the repetition and combination of characters, in favour of the correctness of the received method of reading.

The correctness of the ordinary key is maintained by the strongest internal evidence. Nor does it want the support of external evidence likewise. The Book of Leinster, a MS. of the middle of the twelfth century, contains a passage in which it is briefly given. The Book of Ballymote, written about the year 1370, contains an elaborate tract, which furnishes us with the keys to the ordinary Ogham, and a vast variety of ciphers, all formed on the same principle.

The Book of Lecan (written in the year 1417) contains a copy of the Uraicept, a grammatical tract, probably as old as the ninth century, in which are many passages relating to the Ogham alphabet, and all agreeing, as regards the powers of the characters, with what is laid down in the treatise on Oghams in the Book of Ballymote. Dr. O'Connor, indeed, speaks of a manuscript book of Oghams written in the eleventh century, and once in the possession of Sir James Ware. Mr. Graves has ascertained that this is merely a fragment of the above-mentioned Ogham tract. It is now preserved in the library of the British Museum, and does not appear to have been written earlier than the fifteenth or sixteenth century.

The prevalence of the opinion that the ordinary key was inapplicable, is attributed by Mr. Graves to the ill success of those who have attempted to make use of it; and he accounts for their failure by reference to the following circumstances:

1. The nature of the character is such that it does not at once appear which, of four different ways of reading, is the right one.

2. The words, as in ancient MSS. being written continuously, there is great chance of error in dividing them.

3. The names occurring on the monuments are generally Irish ones latinized in a pedantic manner.

Professor Graves then proceeded to describe several Ogham monuments, of which he exhibited drawings, and gave the readings of the inscriptions on them. As regards their general nature, these monuments resemble those ancient Christian sepulchral monuments in Cornwall and Wales, of which the two following may be taken as types:

VINNEMAGLI

SASRANI FILI CUNOTAMI.

It would seem that a word signifying "*the stone*" is understood before the proper name. It is supplied in the case of a remarkable and very ancient monument, described and figured by Dr. Petrie in his Essay on the Round Towers, p. 164.

The inscriptions in the Ogham character, as they stood originally, were, with few exceptions, read from left to right. Beginning from the lower part of the stone, on which they were engraved, though not at the very extremity of it, they run *upwards*, and the line of characters is frequently carried on over the top of the stone, and then *down* along another of its faces or angles. Some of the names on the stones are actually Latin. For instance, a stone figured in the Proceedings of the Academy, Vol. II., p. 516, fig. 3, bears the name SAGITTARI. A French bishop of the same name lived in the middle of the sixth century. Another stone, found in the barony of Corkaguiny, in the county of Kerry, has the name MARIANI inscribed upon it. In general the names appearing on the stones are such as commonly occur in early Irish church history, sometimes, however, slightly modified in the attempt to give them a Latin form. A finely preserved stone at Emlagh East, near Dingle, presents the name BRUSCCOS, which belonged to an ecclesiastic contemporary with St. Patrick.

Another, found at Ballyneesteenig, bears that of Moinuna, a distinguished disciple of St. Brendan. Many are marked with crosses of an ancient form.

The conclusion to which Mr. Graves has arrived, as regards the age of the Ogham writing, is, that it does not belong to the period antecedent to the introduction of the Latin language and Christianity into Ireland: in short, that it is an invention of the early monkish period.

That the alphabet is not a very ancient one is sufficiently manifested by the arrangement of the letters.

The five vowels, *a*, *o*, *u*, *e*, *i*, are formed into a group arranged in that order; thus manifesting the art of the grammarian in distinguishing vowels from consonants, and again, in dividing the vowels into the two classes of broad and slender. It may be added that the steganographic character of the Ogham presupposes the existence of an older alphabet of the ordinary kind.

A comparison of the Ogham alphabet with the Persepolitan and Phœnician alphabets, manifests that the pretended relationship between it and them has no existence.

The single fact of the Ogham inscriptions indicating an acquaintance with the Latin language might be considered sufficient proof that they are not remnants of a Pagan civilization anterior to the introduction of Christianity into Ireland. For, whatever may have been asserted with respect to the influence exercised by Phœnician merchants or colonists upon the religion, learning, and arts of Ireland, it has never been pretended by writers on our antiquities that there existed here, in the remote Pagan times, any active element of civilization, derived from Roman sources. But, in addition to this use of the Latin language in Ogham inscriptions, there are other circumstances relating to them which manifest their connexion with Christian times and usages. A considerable number of the Ogham monuments bear crosses of different forms. In order to get rid of the obvious inference which this fact suggests, some of the antiquaries who maintain the Pagan origin of the Ogham character have boldly pronounced the supposed crosses to be Pagan symbols. Others have conjectured that the crosses were inscribed at a comparatively recent period on Pagan monuments previously erected. In reply to the former assertion, which is unsupported by anything like proof, it is enough to state that the crosses are undoubtedly Christian, being perfectly similar in form to those occurring on early Christian monuments in this country and elsewhere. The latter hypothesis fails to account for the presence of the cross on the stone of *Marianus* above mentioned, that name being decidedly Christian. Moreover, there seem to be not the slightest grounds for doubting that the crosses on many of the stones are of the same date as the inscriptions which they bear. If it be asked why these monuments do not *all* bear the sign of the cross, supposing that they all belong to the Christian time, it is answered that some of them, for what we know, *may* have been the monuments of Pagans, seeing that Paganism survived in Ireland for centuries after the coming of St. Patrick. But it seems much more probable that they are the sepulchral monuments of Christians, on which the cross was not placed, either for special reasons, having reference to the individuals, or because it was not the custom of the time or place. There are similar pillar-stones in Cornwall and Wales, undoubtedly Christian monuments, on which the cross is wanting.

Another significant fact in connexion with the use of the cross on Ogham monuments is their general occurrence in localities where there yet remain traces of ancient ecclesiastical or monastic institutions. Thus, not to mention instances where Ogham monuments are found in the burial grounds attached to existing churches, the site of a group of Ogham stones, on the shore of Smerwick harbour, still retains the name of a church, *Kilvickillan*. So, again, the remarkable cave at Dunloe, which contains several inscribed stones, has in its immediate neighbourhood a "*holy well,*" named *Toberchrist.* Both these places have been hastily presumed to be Pagan cemeteries.

It appears scarcely accidental that in four instances groups of Ogham stones, seven in number, should have been discovered together. It is not improbable that these were the grave-stones of monks, whom we know to have been in the habit of living together in companies of seven.

The chief objection raised by those who assert the Pagan character of the Ogham monuments, rests on the discovery of so many of them in the interior of *raths.* That this objection should have any weight it must be assumed that the rath was a structure confined to the Pagan times, and employed by Pagans only. So far, however, is this from being true, that we have on record abundant proofs that rath-building was in use amongst the Christian inhabitants of Ireland from the time of St. Patrick down to the middle of the thirteenth century. Churches were built in raths, and raths round churches, no doubt for the purpose of securing protection for the persons and property of ecclesiastical establishments in unsettled times.

Mr. Graves stated that in prosecuting these researches he had received most valuable aid from Mr. Richard Hitchcock, a young gentleman who has devoted much of his time and energies to the search after Ogham inscriptions. Mr. Hitchcock has furnished him with no less than eighty-five sketches made from the monuments, and executed with the most scrupulous accuracy. Access to the collection of Oghams preserved in the museum of the Cork Institution was procured for Mr. Hitchcock by Mr. John Windele, of that city, to whom, on that account, and also for his kindness in communicating information respecting the locality of Ogham monuments said to exist in different parts of Ireland, Mr. Graves acknowledged himself much indebted. He availed himself of the same opportunity to express his regret that Mr. Windele, who had exhibited so much zeal and diligence in the discovery of

Ogham monuments, and to whom belongs the credit of having kept the attention of Irish antiquaries fixed on their importance, should not have published before now the collection of inscriptions of which he has long been in possession; accompanying each sketch with an exact description of the nature of the monument, its locality, and the circumstances attending its discovery. Such an assemblage of facts would have been of the utmost value, as presenting the decipherer with the materials necessary for him to work on. Mr. Graves stated, at the same time, that he did not concur in the readings and translations of Ogham inscriptions given in Mr. Windele's valuable work entitled "*Notices of Cork.*" Reference was made to one inscription in particular, given in page 128 of that work, in the deciphering of which Sir William Betham and the Rev. Matthew Horgan have committed the error of reading the line of characters from the top of the stone downwards, instead of in the opposite direction. The stone actually bears a name which is found on another monument in the county of Cork.

In conclusion, Mr. Graves stated that he would postpone to another occasion the reading of that part of his paper which refers to the origin of the Ogham character, and the relation which it bears to secret alphabets used in other countries.

June 12, 1848.

REV. HUMPHREY LLOYD, D. D., President, in the Chair.

The President read a paper "On certain questions connected with the Reduction of Magnetical and Meteorological Observations."

It is well known that the mean value of any magnetical or meteorological element, for any day, may be had approximately, by taking the *arithmetical mean* of any number of observed values obtained at *equal intervals* throughout the twenty-four hours; the degree of approximation, of course, increasing with the number. It is important to ascertain the law which governs this approximation.

Any periodical function, u, of the variable v, being represented by the formula

$$u = a_0 + a_1 \sin (v + \alpha_1) + a_2 \sin (2\, v + \alpha_2) + \&c.,$$

in which a_0 is the true mean, or

$$a_0 = \frac{1}{2\pi} \int_{-\pi}^{\pi} u dv,$$

if u_1, u_2, u_3, &c., u_n, denote the values of the function u, corresponding to those of the variable

$$v, \quad v + \frac{2\pi}{n}, \quad v + \frac{4\pi}{n}, \ \&c. \quad v + \frac{2\,(n-1)\,\pi}{n},$$

it may be shown that their arithmetical mean is equal to

$$a_0 + a_n \sin (nv + \alpha_n) + a_{2n} \sin (2\, nv + \alpha_{2n}) + \&c.,$$

whatever be the value of v. Hence, as the original series is always convergent, we have, when the number n is sufficiently great,

$$a_0 = \frac{1}{n} (u_1 + u_2 + u_3 + \&c. + u_n),$$

nearly; the error having for its limit

$$a_n + a_{2n} + \&c. = a_n, \text{ nearly.}$$

Hence, when the period in question is *a day*, we learn that the *daily mean value* of the observed element will be given by the mean of *two* equidistant observations, nearly, when a_2 and the higher coefficients are negligible; by the mean of *three*, when a_3 and the higher coefficients are negligible; and so on.

The coefficient a_2 is small in the case of the temperature; the curve which represents the course of the diurnal changes of temperature being, nearly, the curve of sines. In this case, then, the mean of the temperatures at any two *homonymous* hours is, nearly, the mean temperature of the day. This fact has been long known to meteorologists.

The coefficient a_3 is small in *all* the periodical functions with which we are concerned in Magnetism and Meteorology; and therefore the daily mean values of these functions will be given, very nearly, by the mean of any *three* equidistant observed values. To show this, the author gives the four following groups of results, obtained by combining *three eight-hourly* values of the magnetic declination, the atmospheric pressure, and temperature. The results combined, u_1, u_3, u_5, &c., are the yearly mean values corresponding to the hours 1, 3, 5, &c., *reckoned from midnight*, as deduced from the observations made in the Magnetical Observatory of Dublin in 1843. The mean of all the values, corresponding to the twelve hours of observation, is denoted by a.

Means.	Declin.	Pressure.	Temperature.
$\frac{1}{3}(u_1+u_9+u_{17})-a$	+0′·5	+·0005	+0″·1
$\frac{1}{3}(u_3+u_{11}+u_{19})-a$	−0·3	+·0005	0·0
$\frac{1}{3}(u_5+u_{13}+u_{21})-a$	−0·1	−·0005	−0·3
$\frac{1}{3}(u_7+u_{15}+u_{23})-a$	0·0	−·0005	+0·2

It appears, then, that three equidistant observations are sufficient to give the daily mean values (and therefore also the monthly and yearly mean values) for each of these elements. In choosing the particular hours for a continuous system of observations, we should select those which correspond nearly to the maxima and minima of the observed elements, so as to obtain also the *daily range*. This condition is fulfilled, in the case of the magnetic declination, very nearly, by the hours 6 A. M., 2 P. M., 10 P. M.; and if we add the intermediate hours 10 A. M., 6 P. M., we shall have, nearly, the principal maxima and minima of the other two magnetical elements, the maximum of temperature, and the two maxima of pressure. The author accordingly proposes, as the best hours of observation in a limited system,

6 A. M., 10, 2 P. M., 6, 10.

The case is different where the course of the diurnal curve has been already obtained from a more extended system of observations. In this case the mean of the day may be inferred from observations taken at *any hours* whatever; and the hours of observation should therefore be chosen, chiefly, if not exclusively, with reference to the diurnal range of the observed elements.

The author proceeds, in the next place, to consider the course to be pursued in the reduction of a more extended system of observations (such as that prescribed by the Royal Society in 1839, and adopted by all the Magnetical Observatories), when some of the observations are deficient. He shows that, in this case, in deducing the daily means from the remaining observations, we must attend, not only to the elimination of the regular diurnal variation, but also to that of the irregular changes of longer periods, which are sometimes (as in the case of the atmospheric pressure) more influential in the result. With this view he determines the values of the *mean daily fluctuation* for each of the elements already referred to; and compares the mean values of the horary changes thence arising with that resulting from the regular diurnal variation.

The author shows, finally, in what manner the *monthly means* of the results obtained at any hour are to be corrected in the case of deficient observations, so as to render them comparable with those in which none are wanting; and he deduces the probable values of these corrections for each element, with the view of ascertaining in what cases the correction may be disregarded, and in what it is indispensable.

Professor Graves exhibited and described a silver brooch, belonging to the Royal Dublin Society, and bearing on it an inscription in the Ogham character.

Vallancey gives the following account of its discovery:

"This brooch was discovered by a peasant, turning up the ground on the hill of Ballyspillan, on the farm of Charles Byrne, Esq., the estate of Lord Ashbrook, in the barony of Galmoy, in the county of Kilkenny, in the month of September, 1806."—*Collectanea*, vol. vii. p. 149.

The front of the brooch is ornamented by a device of entwined serpents, such as is met with frequently on objects of the same kind. The back presents four lines of writing in the Ogham character, which read thus:

Minoꝺoꞃ muaꝺ
Cnaemꞅeoch Ceallach
Maeolmaiꞃeo
Maeoluaꝺaiᵹ Maeolmaiꞃeo.

Mr. William Halliday, using the ordinary key, deciphered these words pretty correctly; but in translating them he had gone astray, in consequence of his not perceiving that, with the exception of the second, they are all proper names.

Professor Graves, hoping by means of the names to determine the date of the inscription, requested Mr. Eugene Curry to search for them amongst the pedigrees of the families which have inhabited the district where the brooch was found. The search was not fruitless; the name Cnaemꞅeoch, a name of rare occurrence, was found in a genealogy in the Book of Lecan (folio 108 b. col. 2), as belonging to a person in that country, the fourteenth in descent from Ꞇuaimꞅnaṁa, who, as we learn from the Annals of the Four Masters, was killed A. D. 676. Allowing thirty years to a generation, this would bring the time of Cnaemꞅeoch down to about the year 1100. The names Ceallach and Maeolmaiꞃeo are too common to be of any use in ascertaining the date of the brooch, or the identity of the other persons named on it.

J. Huband Smith, Esq., exhibited to the Academy a fac simile made from a rubbing of an ancient inscription in the ruined church of Rathmore, near Kells, in the county of Meath. This inscription remains on a stone tablet inserted in the southern wall of the interior of this church. The tablet measures three feet and one inch in length, by one foot and three inches in height; and is said to have been originally placed above the northern porch, a supposition which the terms of the inscription appear to favour. The words are much contracted, and are elegantly cut, in the black letter character of the fifteenth and sixteenth centuries. The inscription runs thus:

Orate p aiab^{s} Cstofori Pluket de Rathmore Milit^{s} & Ratne Pston uxis ei^{s} q cruce lapidea infra villa ista ante cimiteriu costructerut & porticu istu et oib^{o} ante cruce pdicta dicent^{s} pr nr & ave ma p aiab^{s} dtoru Cstofori & Ratne & parentu suoru cocessu est ducent dies indulgecie p v epos i coci^{o} Pviciali toties qties Petuis tepib^{s} duraturis. A^{o} dni M^{o}ccccc^{o}xix^{s}.

Without the contractions, it reads as follows:

ORATE PRO ANIMABUS CRISTOFORI PLUNKET DE RATHMORE MILITIS ET KATERINÆ PRESTON UXORIS EJUS QUI CRUCEM LAPIDEAM INFRA VILLAM ISTAM ANTE CIMITERIUM CONSTRUCTERUNT ET PORTICUM ISTUM ET OMNIBUS ANTE CRUCEM PRÆDICTAM DICENTIBUS PATER NOSTER ET AVE MARIA PRO ANIMABUS DICTORUM CRISTOFORI ET KATERINÆ ET PARENTUM SUORUM CONCESSUM EST DUCENTI DIES INDULGENCIÆ PER QUINQUE EPISCOPOS IN CONCILIO PROVINCIALI TOTIES QUOTIES PERPETUIS TEMPORIBUS DURATURIS ANNO DOMINI M°.CCCCC°.XIX°.

This porch has long since fallen to the ground, and the whole church is now a ruin of much picturesque beauty; the great eastern window, and a square tower of considerable height, still presenting objects of no little interest to the lovers of ecclesiastical architecture and antiquities.

The Plunkets of Rathmore were a distinguished branch of a family long settled in the county of Meath; and Christopher Plunket, whose name occurs in this inscription, was the son of Alexander Plunket, who was made Lord Chancellor of Ireland 11th June, 1492, and died in the year 1500.

The inscription is one of some value, not only as one of the few existing records of the objects had in view by persons who erected churchyard and way-side crosses in Ireland, but also as recording the holding of a provincial council by five bishops, of which, possibly, no other memorial has survived. The tombstone of the same Christopher Plunket, which is in another part of this church, states his death to have occurred on the fifth day of March, in the year 1519, the same year in which the above-mentioned tablet records the erection of the cross. His wife appears, by the blanks left in the following inscription for the date of her decease, to have survived him.

The inscription on this tombstone is as follows:

" Hic jacet Cristoforus Plunket de Rathmore, Miles, cum Domina Katerina Preston uxore sua. Obiit quinto die mensis Martii Anno Domini M° CCCCC° XIX. Et dicta Katerina obiit . . . die mensis . . . . . Anno Domini . . . . . Quorum animabus propicietur Deus, Amen."

The base of the cross yet remains in the churchyard, on the north side of the church. Its shaft and cruciform head are probably buried somewhere in the ruins. A few words, however, of a mutilated inscription on the base, in which the name and date are yet discernible, sufficiently identify it with the cross referred to in the tablet above described. Rathmore was originally the estate of the Cruises, and was brought into the Plunket family by the marriage of Thomas Plunket with Maria Cruise. On the still remaining base of a cross with ecclesiastical figures, on the demesne of Killeen, is this inscription:

" Thomas Plunket—Maria Cruys."

And the obit of Sir Thomas Plunket is thus given in the Killeen mortiloge, Cusake MSS.:

" Obitus Thome Plunket militis dn̄i de Rathmore, Capitūs Iustic' Do. Regis Hibn. qui obiit xiii. die Junii, Anno dn̄ m.cccc.lxx° i°."

The tombstone of Christopher Plunket and Dame Katherine Preston, before mentioned, bears the arms of Plunket, Preston, and Molyneaux (called on it Molines); Katherine Preston being the daughter of Robert Lord Gormanston, by his wife, Genet, daughter of Sir Richard Molyneaux. See Lodge's Peerage, Archdall's Edit., vol. iii., page 245.

There are several other monuments within this church, well worthy of attention. One represents an armed knight, in a very elegant and peculiar coat of mail, and having an inscription round the edge, which, though much defaced, might yet be, in part at least, recovered. Another, being a portion, as may be presumed, of a monument of considerable importance, has been let into the wall of the church, and is sculptured with eight shields, seven of which contain various coats of arms, and the eighth the emblems of the passion of our Lord.

It is deserving of the highest commendation that these ruins are, with good taste and good feeling, protected from wanton or idle injury by the tenant of the adjoining farm; who, not long since, at his own expense, preserved the beautiful east window from being lost, having judiciously replaced some of the stone mullions, which, loosened by the hand of Time, had fallen down, and the want of whose support threatened to bring the whole of the tracery speedily to the ground.

Dr. Lentaigne presented, on the part of Mr. Peter Quin, some portions of a skeleton, an urn, and a fragment of another, all found on the townland of Kiltalown, close to the boundary of Killinarden, and in the parish of Tallaght, on the lands of John Robinson, Esq.

These ancient remains were discovered last week, by the tenant of the land, Mr. Quin, who was endeavouring to clear and level a furzy field, situated near the top of the ridge of the hill of Tallaght. On removing some of the surface clay of a low mound, he first found a quantity of broken stones, and under them a large stone. He supposed this to be the quarry that appeared in several places through the soil in the immediate neighbourhood of the place. On trying to break the large stone, or move it with crowbars, it was ascertained that it was not very thick; and with the assistance of a large sledge hammer it was broken into several pieces. One of these fell down, leaving an opening in the roof of a chamber or tomb. The stone now broken appeared to have been originally placed on others, which formed the sides of a complete kiswain, very similar to that described in the Proceedings of the Academy (vol. i. p. 188). Like that one found in the Phœnix Park, it contained a skeleton, whose head has all the characteristics which distinguish the two found in that tomb; but in this, the vase or urn, herewith presented, was found within the limits of the chamber, and placed on the north side of the skeleton. It was about half full of a black sooty substance, but it contained no bones like the urns found in the Park. Its contents were examined by the people present, and, not being supposed to be of any interest, were thrown away.

Near the tomb were discovered a number of small chamber tombs, without covering stones. These had all been previously opened. Fragments of burned bones were discovered in several; and on the east of the kiswain was found a pit, about five feet deep, with walled sides. This appeared to have been used as a depository for burned bones and ashes, with which it was filled. At some distance the fragment of the urn also presented was found near the surface. The character or style of the workmanship differs from that of the urn found in the tomb, but it exactly resembles an urn in the Museum, found, under similar circumstances, at the hill of Rath, near Drogheda.

Professor Graves communicated the following note:

It has been shown by Professor MacCullagh[*] that the equation of the central surface of the second order,

$$\frac{x^2}{a_0^2} + \frac{y^2}{b_0^2} + \frac{z^2}{c_0^2} = 1,$$

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[*] Proceedings of the Royal Irish Academy, vol. iii. p. 429.

may be reduced by a transformation of coordinates to the form

$$\frac{\xi^2}{k^2} + \frac{\eta^2}{k'^2} + \frac{\zeta^2}{k''^2} = (f-1)\left\{\frac{\xi_0\xi}{k^2} + \frac{\eta_0\eta}{k'^2} + \frac{\zeta_0\zeta}{k''^2} - 1\right\}^2$$

The new origin being fixed at any point in space $(x_o\ y_o\ z_o)$, the normals to the three confocal surfaces of the second order passing through that point are made the new axes of the rectangular coordinates, ξ, η, ζ. The quantities k^2, k'^2, k''^2, are determined by the equations $k^2 = a^2 - a_o^2$, $k'^2 = a'^2 - a_o^2$, $k''^2 = a''^2 - a_o^2$, in which a^2, a'^2, a''^2, are the squares of the primary semi-axes of the three confocal surfaces; f stands for the quantity

$$\frac{x_o^2}{a_o^2} + \frac{y_o^2}{b_o^2} + \frac{z_o^2}{c_o^2};$$

and ξ_o, η_o, ζ_o, are the coordinates of the centre of the surface.

It has also been observed by the same geometer, that

$$\frac{\xi^2}{k^2} + \frac{\eta^2}{k'^2} + \frac{\zeta^2}{k''^2} = 0$$

is the equation of the cone whose vertex is at the point $(x_o\ y_o\ z_o)$, and which envelopes the surface $(a_o\ b_o\ c_o)$; whilst

$$\frac{\xi_0\,\xi}{k^2} + \frac{\eta_0\,\eta}{k'^2} + \frac{\zeta_0\,\zeta}{k''^2} = 1$$

is the equation of the plane of contact of the cone and surface.

From this form of the equation of the surface of the second order we are enabled to deduce a general theorem; the consideration of a particular case of which suggests a simple proof of Joachimsthal's theorem concerning geodetic lines, $PD = Const.$

If a perpendicular P *be let fall from the centre of a surface of the second order* $(a_o\ b_o\ c_o)$ *upon any tangent plane to a cone enveloping the surface, we shall have*

$$\frac{1}{P^2L^2} = \frac{\text{Cos}^2\alpha}{(a^2-a_o^2)^2} + \frac{\text{Cos}^2\beta}{(a'^2-a_o^2)^2} + \frac{\text{Cos}^2\gamma}{(a''^2-a_o^2)^2};$$

where L *is the length of the side of contact; α, β, γ, are the angles it makes with the axes of the cone; and a, a', a'' are* *the primary semi-axes of the three surfaces confocal to* $(a_0\, b_0\, c_0)$, *which intersect at its vertex.*

This theorem may be proved as follows: The equation of the tangent plane to the cone is

$$\frac{\xi'\xi}{k^2} + \frac{\eta'\eta}{k'^2} + \frac{\zeta'\zeta}{k''^2} = 0,$$

ξ', η', ζ', being the co-ordinates of the point on the surface $(a_0\, b_0\, c_0)$, touched by the plane; and the square of the perpendicular P let fall from the centre on it is given by the formula,

$$P^2 = \frac{\left\{\dfrac{\xi'\xi_0}{k^2} + \dfrac{\eta'\eta_0}{k'^2} + \dfrac{\zeta'\zeta_0}{k''^2}\right\}^2}{\dfrac{\xi'^2}{k^4} + \dfrac{\eta'^2}{k'^4} + \dfrac{\zeta'^2}{k''^4}}$$

But, since the point $(\xi'\, \eta'\, \zeta')$ lies in the plane of contact, the numerator in this expression is equal to unity. Therefore, if we put

$$\xi' = L \cos \alpha, \quad \eta' = L \cos \beta, \quad \zeta = L \cos \gamma,$$

we shall obtain the result stated above.

The quantity PL is evidently the same for the four sides of the cone L, L', L'', L''', whose directive angles are respectively (α, β, γ), $(\alpha, \pi - \beta, \gamma)$, $(\alpha, \pi - \beta, \pi - \gamma)$, $(\alpha, \beta, \pi - \gamma)$; and, if we denote by D the semidiameter of the surface parallel to L, the quantity PD will likewise be the same for them all; since the sides of the cone are proportional to the parallel semidiameters. Again, the planes of L and L'', L' and L''', pass through the internal axis of the cone; whilst those of L and L', L'' and L''', L' and L'', L''' and L, pass through its external axis.

Let us now suppose the vertex of the cone to approach indefinitely near to a point V on the surface: its internal axis becomes the normal; and the external axes ultimately coincide in direction with the tangents to the two lines of curvature passing through the point V. L and L'' may now be regarded as two successive elements of a geodetic line, since their plane contains the normal. And, as it has been proved already that the quantity PD is the same for both of them, we are now in possession of a proof that, in passing from one element to the adjacent one, along a geodetic line traced on a central surface of the second order, the quantity PD remains unaltered. Let us next inquire what becomes of L and L' in the extreme case under consideration. These lines may be regarded as ultimately the elements of two lines making equal angles with the lines of curvature passing through V. We have, therefore, the theorem that if two right lines touch a surface of the second order at the same point, making there equal angles with a line of curvature passing through it, the quantity PD is the same for both. And, as a particular case, we have the theorem that, in passing from one element to the adjacent one, along a line of curvature traced on a central surface of the second order, the quantity PD remains unaltered.

Returning now to the case in which the vertex of the cone is supposed to be at a finite distance from the surface, we see that the four sides, L, L', L'', L''', are tangents to geodetic lines for which the quantity PD is the same, and which, therefore, touch the same line of curvature; and conversely, if two rectilinear tangents to the same geodetic line, or to geodetic lines for which the quantity PD is the same, intersect each other, they make equal angles with the axes of the cone which, from this point of intersection, envelopes the surface.

When the enveloping cone becomes a right one, we have PL or PD the same for all its sides; the geodetic lines to which they are tangents must, therefore, all converge to the same umbilic.

From what has been already stated, it is easy to deduce the following theorems:

If a closed flexible and inextensible cord be kept stretched by a style, being partly in free contact with a surface of the second order along a geodetic line, and partly free in space, *the style at the point of intersection of its straight portions will trace out another geodetic line upon a confocal surface.*

And, if it be kept stretched, being partly in constrained contact with the surface along a line of curvature, and partly free in space, the style will trace another line of curvature upon a confocal surface.

JUNE 26, 1848.

REV. HUMPHREY LLOYD, D. D., PRESIDENT, In the Chair.

Sir W. R. Hamilton stated the following additional theorems respecting certain reciprocal surfaces, to which his own methods have conducted him.

If a plane quadrilateral $ABCD$ be inscribed in a given sphere, so that its four sides may be constantly parallel to four given straight lines; and if E, F be the two points of meeting of the two pairs of opposite sides, namely, E the meeting of the sides AB, CD, and F the meeting of BC, DA (prolonged if necessary); then the locus of the point E will be one ellipsoid, and the locus of the point F will be another ellipsoid reciprocal thereto.

And other pairs of reciprocal surfaces of the second degree may be generated in like manner, by changing the sphere to other surfaces of revolution of the second degree.

For instance, a pair of reciprocal cones of the second degree may be generated as the loci of two points E, F, which are, in like manner, the points of meeting of the opposite sides of a plane quadrilateral $ABCD$, inscribed in a circular section of a right-angled cone of revolution, with their directions in like manner constant. And a pair of reciprocal hyperboloids (whether of one or of two sheets) may, in like manner, be generated from an equilateral hyperboloid of revolution (of one or of two sheets).

The writer may take this opportunity of mentioning a result which lately occurred to him, respecting two *arbitrary*, but *reciprocal* conical surfaces, of which each is the locus of all the normals to the others, erected at their common vertex; namely, that two such cones have always one common conical surface of centres of curvature.

The President read the following Address:

Gentlemen,—We have this night reached the close of a Session of more than usual activity; and I might, therefore, naturally have desired—before leaving this Chair and adjourning the Academy to another winter—to trespass for a short time upon your attention, and to lay before you a brief summary of the results of our toil. On the present occasion, however, my duty is narrowed and defined; and the recent award of the Cunningham Medals by the Council renders it imperative on me to submit to the Academy the grounds of their decision. In doing this, it will be necessary for me to present a brief analysis of the results of those labours whose value your Council have thus honourably recognised; and in the execution of this task I must request the indulgence of the Academy, and still more that of the gentlemen of whose discoveries I am to speak, if, in my imperfect acquaintance with them, I should fail to do justice to their merits.

You are aware that, during the past Session, the laws respecting the award of medals have occupied the attention of the Council; and that certain new regulations relating to it were, upon their suggestion, adopted by the Academy. It is unnecessary for me to recapitulate these regulations, or to state the grounds for the changes therein made, as this has been already fully done by the Council, in their last Annual Report. It will be sufficient for me, on the present occasion, to remind you, that the principal alteration in the rules respecting the award of medals under the Cunningham bequest, has been to extend the limit within which the Council are enabled to bestow such rewards, and to confine them only to Memoirs or Works printed and published in Ireland, or relating to Irish subjects.

A considerable interval having elapsed since the last award of these prizes, the Council for the present year, on coming into office, referred the matter to the three Committees of which that body is composed. Upon the recommendation of these Committees, in their several departments, the Council have adjudicated Medals to the following gentlemen:

1. To Sir William Rowan Hamilton, for his "Researches respecting Quaternions," published in the twenty-first volume of the Transactions of the Academy.

2. To the Rev. Samuel Haughton, F. T. C. D., for his Memoir "On the Equilibrium and Motion of solid and fluid Bodies," published in the same volume.

3. To the Rev. Edward Hincks, D. D., for his various Papers on Egyptian and Persepolitan Writing, also published in the same volume. And

4. To John O'Donovan, Esq., for his contributions to the Transactions of the Irish Archæological Society, his Irish Grammar, and his edition of the Annals of the Four Masters.

In attempting to lay before the Academy a concise account of the origin of the new Calculus invented by Sir William Hamilton, and of the principles upon which it is based, I shall avail myself of the elucidations and applications of the theory which its gifted author has, from time to time, communicated to the Academy, and of which abstracts have appeared in our Proceedings, as also of the series of Papers published by him in the Philosophical Magazine upon the same subject. Of the latter, the author's letter to John T. Graves, Esq., written immediately after the discovery, possesses a high value, not only as a fragment of scientific history, but still more, as laying bare in a new instance that most interesting and instructive of all the mental phenomena,—the actual train of thought which takes place in the creative mind, from the first dawn of Truth within it to its full and noon-tide effulgence.

It is now twenty years since the Rev. Mr. Warren of Cambridge* showed that the ordinary imaginary symbol ($\sqrt{-1}$) had a geometrical significancy, and may denote a right line whose length is equal to unity, measured, not on the axis of the real units, but on an axis *at right angles* to it. It followed from this, and from another principle respecting the symbolical meaning of the sign +, as applied to lines, that the ordinary binomial imaginary, whose real parts, or *constituents*, are multiplied by unity and $\sqrt{-1}$, respectively, may be taken to represent both the *length* and *direction* of a right line in a given plane; the square root of the sum of the squares of the constituents being the length of the line, and their quote, or ratio, the tangent of the angle which it forms with the axis on which the first of them is measured. These quantities have been denominated the *modulus* and the *amplitude* of the imaginary binomial.

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* Since the delivery of this Address the attention of the writer has been directed by Sir William Hamilton to the earlier steps of the inquiry. The first appears to have been made by M. Buée, in a Paper published in the *Philosophical Transactions* for 1806, in which he lays down the prin-

Now, if two such binomials, or *couplets*, be added together, the sum is a binomial of a similar form, or a couplet whose constituents are the *sums of the constituents* of the original couplet. And if two couplets be multiplied together, the product is likewise a couplet; and the relation of the product to the factors is such, that the modulus of the product is the *product of the moduli* of the factors, and the amplitude of the product is the *sum of the amplitudes* of the factors. From these algebraical properties of couplets, combined with their geometrical significancy, it follows that right lines in a plane, having direction as well as magnitude, may be operated upon according to certain simple algebraical conditions, and the direction and amplitude of the resultant lines obtained by certain simple algebraical rules.

It was in the effort to generalize the theory of Couplets, and to extend their properties to right lines *in space*, that Sir William Hamilton was led to the construction of his theory of Quaternions. "Since," he says, "$\sqrt{-1}$ is, in a certain well-known sense, a line

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ciple, that the symbol $\sqrt{-1}$, as applied to lines, denoted *perpendicularity*. A further step was made by M. Argand, in a memoir published at Paris in the same year, in which he shows that the sum of two lines, estimated in direction as well as magnitude, is the diagonal of the parallelogram constructed upon them. The subject was resumed and more fully developed by M. Francais, in a memoir published in the *Annales des Mathematiques* for 1813.

perpendicular to the line 1, it seemed natural that there should be some other imaginary to express a line perpendicular to both the former; and because the rotation from 1 to this also, being doubled, conducts to − 1, it also ought to be a square root of negative unity, though not to be confounded with the former."

Starting thus with the conception of *triplets* involving two distinct square-roots of negative unity, and endeavouring to frame laws for their algebraical treatment, analogous to those which hold in the case of couplets, he was soon led to perceive that the existence of the two imaginaries, just alluded to, necessarily involved the existence of a *third*, which was also a square-root of negative unity, distinct from either of the former. He was thus led to the conception of *quaternions*, or quadrinomials whose real parts, or constituents, are multiplied, the first by unity, and the other three by the three imaginary roots of negative unity just referred to; and he determined the conditions which must subsist amongst these new imaginary coefficients, in order that the resulting quadrinomials should be subject to the same algebraical laws as the ordinary imaginary binomials, or couplets.

I may here observe, in passing, that one of these laws, namely, the law of the moduli, is equivalent to a celebrated theorem of Euler; viz.: that the sum of four squares, multiplied by the sum of four squares, is also a sum of four squares. An extension of this theorem to sums of *eight* squares has been effected, independently, by Mr. John Graves and Professor Young; and the latter writer (whose paper on the subject is published in the last part of the Transactions of the Academy) has proved that the property cannot be extended to higher numbers.

To return to the Quaternion,—we have seen that it is made up of a *real* part, and an *imaginary trinomial*, using the terms *real* and *imaginary* in their ordinary acceptation. The latter of these represents a *right line in space*, drawn from the origin to the point whose co-ordinates are the three constituents of the trinomial, and it is accordingly designated by Sir William Hamilton by the term *vector*. The real part of the quaternion, on the other hand, designates *number* alone, whether positive or negative, without direction in space; and, accordingly, although real in the *algebraical* sense of the term, it is in some sense imaginary, when contemplated on the *geometrical* side. This part of the quaternion is denominated by Sir William Hamilton the *scalar*.

Thus we see that a quaternion is reducible to a binomial, the component parts of which—the scalar and the vector—designate, the one a number, the other a line. The whole tendency of the later speculations of the author has been to realize this reduction, and having determined the laws of operation upon scalars and vectors, to dismiss altogether the consideration of the constituents of the vector, and to treat it as a single integral quantity. It is easy to see what amount of simplicity is thus, at one step, introduced into the whole of Geometry and Mechanics. In place of the three co-ordinates (rectilinear or polar) by which the magnitude and direction of a *line*, or of a *force*, are ordinarily determined, the theory of Sir William Hamilton deals with the line itself, or with the force, *directly;* and thus not only is the number of necessary equations reduced at once, in the proportion of three to one, but also the interpretation of those equations is rendered simpler and more direct.

The scalar, or algebraically-real part of the quaternion, thus appearing to have no direct geometrical significancy, geometers seemed inclined to regard it as a sort of intruder in their domain; and I believe it was to the desire to exclude it, that we may, in part, attribute the very elegant and ingenious theories of *triplets*, invented by Professor De Morgan and Professor Graves. The scalar, however, is represented in mechanics by the *time;* and even in its application to pure geometry, Sir William Hamilton has shown that the introduction of this fourth quantity confers power and generality upon the calculus of quaternions, inasmuch as no direction in space is thus selected as eminent above another, but all are regarded as equally related to the *extra-spatial*, or scalar direction. The calculus thus frequently admits of a simpler and more direct application to geometrical problems than the Cartesian method of coordinates, inasmuch as it demands no previous selection of arbitrary axes.

I may observe, also, that in the triplet theories of Professor De Morgan and Professor Graves, the law of the moduli is not preserved, if the term modulus be taken in its ordinary signification,—

it being not generally true that the sum of *three* squares, multiplied by the sum of three squares, is a sum of three squares.

But whatever be thought of the principles of the Calculus of Quaternions, its advantages as an instrument of Mathematical Thought will undoubtedly be judged by the simplicity and ease with which it may be applied. In this the author has already done enough to establish its power. He has applied it with great success to many problems of the geometry of Surfaces; and he has given a sketch of its application to the problem of the Three Bodies, and to the Mechanics of the Heavens generally. These instances of its application,—whether we look to the elegance and simplicity of the method, or to the beauty and symmetry of the results,—are abundantly sufficient to demonstrate the power and pliancy of the instrument.

Still, however, more will be required from its author, before the weapon which he wields with a giant's grasp may be touched by feebler hands. It will be necessary that the principles and fundamental rules of the calculus should be rendered familiar by elementary exposition, and their certainty tested by ordinary applications, before the violation of known analogies which some of them present will be universally acquiesced in; and I am happy to be able to say that the large debt, which Science already owes at his hands, is likely to receive ere long this addition, and that, like a genuine lover of Truth, he will not rest content until the difficult path which he has cut for himself into her tangled and obscure recesses shall become a highway for all.

I now proceed to the consideration of Mr. Haughton's Memoir "On the Equilibrium and Motion of solid and fluid Bodies."

The object of this Memoir, as stated by the author himself, is "to deduce, by the method of the *Mecanique Analytique* of Lagrange, the laws of equilibrium and motion of elastic solid and fluid bodies from the same physical principles, and to discover by the same method the conditions at the limits." The method of Lagrange (which is so peculiarly adapted to the mechanics of a system composed of an indefinite number of acting molecules, situated indefinitely near each other), seems to have been first applied to the problem of elastic bodies by M. Navier, who determined by that method the laws of *equilibrium* of a *homogeneous* uncrystallized solid.

The late Mr. Green, of Cambridge, applied the same method to the more difficult *dynamical* question of the movement of the molecules of the *luminiferous ether;* in which application he was followed, but with more success, by the distinguished mathematician, whose name is imperishably connected with the records of this Academy.

Mr. Haughton has judiciously adopted the same mathematical method; and he has determined the form of the function which enters the general equation of Lagrange (and which depends upon the *internal forces* acting at any point of the medium), from the assumed principle, that the molecules of solid and fluid bodies act on each other *only in the direction of the line joining them*, and with forces which depend on the magnitude and direction of that line. This function is easily shown to consist of two parts, one of them depending on the first power of the displacement, and the other upon its square; the former of which is assumed to relate to *perfect fluids*, and the latter to *solids*, while both must be taken into account in *imperfect* or *viscous fluids*. The form of this function, in the case of solids, bears some analogy to, although it is quite different from, that of the function employed by Professor Mac Cullagh in his dynamical theory of light; and the author deduces, from that difference, the important physical consequence that the molecules of the luminiferous ether do not, according to that theory, act on one another in the direction of the line joining them.

The differential equations of motion cannot be integrated generally; but the values of the three component displacements which correspond to the case of *plane waves*, are manifestly particular integrals; and the equations of condition, which result from the substitution of these values in the general equations of motion, lead to a remarkable geometrical construction for the three possible *directions of molecular vibration*, and the corresponding *velocities of the plane waves*, by means of six fixed ellipsoids.

The author then determines the equation of the *surface of wave-slowness* (or the reciprocal polar of the wave-surface), the nature and properties of which are analogous to those of the surface of the same name in the theory of light. This surface is of the *sixth* degree, and has *three* sheets, corresponding to the three velocities of wave propagation; and, like the corresponding surface in the theory of light, it serves to determine the direction of the refracted waves, in passing from one medium to another, as well as the laws of propagation in the same medium. In the most general case considered by the author,—namely, when the molecules of the medium are arranged *symmetrically round three rectangular planes*,—it is shown that this surface has *four nodes*, at which the tangent plane is a cone of the second degree; and thence arises a conical refraction in Sound, similar to that discovered theoretically by Sir William Hamilton in the case of Light.

That such analogies, and points of correspondence, should exist between the theory of light and any general theory of vibration in crystalline solids, was, of course, to be expected from the common foundation and the common postulates of the two theories. Notwithstanding this, however, the two theories diverge at a very early point. In both, indeed, the form of the characteristic function is deduced from the assumed molecular constitution of the medium. But that constitution is essentially different in the two cases,—the fundamental molecular property of the luminiferous ether, in the theory of Professor Mac Cullagh, being the unchangeableness of its density, while the corresponding basis of the theory of Mr. Haughton is the property that the molecules of the medium act on one another in the direction of the joining line.*

In conclusion, I may observe that the value of Mr. Haughton's theory—considered on its physical side, and independently of its mathematical elegance—consists in its high degree of generality; which is such, as necessarily to embrace all the fundamental conditions of the problem, and thus to leave to future mathematicians the task only of limiting and interpreting his results.

In speaking of Dr. Hincks's philological researches I must pass over those which relate to Egyptian Hieroglyphics, and hasten to his more recent, and (at the present time) more interesting labours connected with Persepolitan writing. And in order to present an intelligible statement of the nature of these labours, and of the additions which have been thereby made to the existing amount of knowledge upon this curious subject, it will be necessary to take a hurried glance at the history of the investigation, and its principal steps.

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* The theory of Mr. Haughton bears a much closer resemblance, in many of its results, to the wave-theory of M. Cauchy than to that of Professor Mac Cullagh, although it differs from it wholly in method. The theory of M. Cauchy is, in fact, a theory of the laws of propagated vibration in solids, and is inapplicable (as was shown by Professor Mac Cullagh) to light.

The cuneiform writing has been generally reduced to three leading divisions, which have been denominated, respectively, Persian, Median, and Babylonian. Many of the cuneiform inscriptions contain all the three kinds of writing; the first being the principal, and apparently the vernacular record, and the other two translations. They are found on rocks, slabs, and pillars, at Persepolis, at Behistun, at Ván, at Murgháb, and at Hamadán. These trilingual inscriptions are all, without exception, records of the Achæmenian dynasty; the earliest which has been discovered (the inscription at Murgháb, or Pasargadæ) relating to Cyrus the Great, and the latest to Artaxerxes Ochus.

Of the three kinds of writing found in these inscriptions, the first, or Persian, is the simplest, containing the fewest and least complicated characters. It is also distinguished from the other two by the divisions between the words, which are separated by an oblique wedge; and this circumstance, of course, greatly facilitates the task of the decipherer. The second Persepolitan writing appears to have been coeval with the first, and to have been employed only in conjunction with it, in the trilingual monuments of the Achæmenian princes; it is accordingly ascribed by the concurrent voice of philologers to the Medes, the people next in importance to the native Persians under the Achæmenian dynasty. The number of characters in this writing is far greater than in the Persian, its alphabet (or syllabary) containing about 100 letters. The third Persepolitan writing belongs to one of a group of languages (distinguished by Major Rawlinson into the *Babylonian*, the *Assyrian*, and the *Elymæan*) written in a similar character. It is ascribed, with every probability, to the Babylonians, legends in a like character being found on cylinders and bricks excavated from the foundations of the primæval cities of Shinar. It is unquestionably the most ancient of the three kinds of cuneiform writing, and was probably the type upon which the other two were constructed. The characters are more numerous and more complicated than those of the first and second kinds.

The process of resolving and interpreting an inscription in an unknown and extinct language, and written in an unknown character, appears to include three distinct and principal steps. The first of these is that of deciphering (properly so called), or determining the phonetic powers of the letters. The next step is the determination of the nature of the inflections, and the grammatical structure of the language itself, and the discovery of its congeners or representatives amongst the living languages. The third and last step consists in tracing from these sources the meaning of its roots, and thus translating the inscription.

The first of these steps was long since taken, with respect to the first Persepolitan writing. In the year 1802, Professor Grotefend, of Göttingen, examined two short trilingual inscriptions, which had been copied at Persepolis by the traveller Niebuhr, and succeeded in identifying the names of *Cyrus*, *Darius*, *Xerxes*, and *Hystaspes*, in all the three characters. The analysis of these names, in the case of the Persian, enabled him to determine the values of eleven out of the sixteen letters of which they were composed, or nearly one-third of the entire alphabet.

The next step was made by Professor Rask, of Copenhagen, in 1826. He recognised the title *Achæmenide* in the inscription of Niebuhr, and thus determined the values of two important letters, *m* and *n*, which occur in it. But the most valuable contribution made by Rask to this branch of palæography, consisted in his discovery of the resemblance of the extinct language to the Sanscrit in some of its inflections, a discovery which has been justly regarded as the key to its interpretation. Ten years later the inquiry received a fresh impulse by the simultaneous publication of two works, one by M. Burnouf, of Paris, and the other by the distinguished orientalist, Professor Lassen, of Bonn. By the analysis of a trilingual inscription, containing the names of the provinces of the Persian empire, the values of many new characters were ascertained, and the known alphabet was enlarged to twenty-six letters.

In the year 1838 the values of five new characters were added to the list,—two by Dr. Beer, of Leipsic, and three by M. Jacquet, of Paris; and the same writers discovered, independently, the fundamental principle which, strange to say, had hitherto escaped notice, that the Persian alphabet contained but three vowels, *a*, *i*, and *u*.*

But the most important of the researches connected with the first Persepolitan writing are those of Major Rawlinson. Hitherto little had been accomplished beyond the *first* step of the process,—the determination of the values of the letters. Rask, indeed, had observed the similarity of the language to the Sanscrit, and this was confirmed by Lassen and Beer, the former of whom proposed to employ the Sanscrit as a key to its interpretation; but, as yet, little had been correctly done on this head. In 1835 Major Rawlinson commenced his labours, in the country of the inscriptions; rediscovered for himself the greater part of what had been already done by European scholars; and determined the values of, at least, four new characters. But his chief work—in which he has, by one great stride, surpassed all his predecessors—is the translation of the Persian portion of the great trilingual inscription at Behistun, containing above 400 lines of cuneiform writing. This inscription had been copied, in part, by Major Rawlinson in 1837; and a large portion of the translation was made by him, and communicated to the Royal Asiatic Society, in 1839. His philological labours were suddenly interrupted in the following year, by active duty at Affghanistan; but in the autumn of 1845 he succeeded in making a correct copy of the whole of the Persian inscription (together with a considerable portion of the Median and Babylonian), and soon after completed the translation in the form in which it has been recently published. With the contents of this singular record, written more than twenty-three centuries since, and throwing an unexpected light upon one of the most controverted questions of early history, the literary public are now well acquainted.

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* This striking similarity of the Persian to the languages of the Shemitic type, in its vocalic structure, has been recently drawn still closer by Dr. Wall, in his able Paper on the different kinds of cuneiform writing, published in the last volume of the Transactions of the Academy.

Dr. Hincks's first paper on Persepolitan writing was communicated to the Academy in June, 1846, before the publication of the first part of Major Rawlinson's memoir. In this paper he proposes three general principles respecting the orthography of the Persian, in which he corrects Lassen's account of that language. The most important of these consists in the distinction of the consonants into two classes, which he calls primary and secondary,—the former being those which may be used before the vowel *a*, expressed or supplied, the latter such as are only used before one of the other vowels. Dr. Hincks maintains, in opposition to Lassen, that these secondary consonants are phonetically equivalent to their primaries; and he lays it down, "as an invariable rule, that if a primary consonant precedes *i* or *u*, when a secondary consonant existed of the same value as the primary one, and appropriate to that vowel, an *a must* be interposed, either as a distinct syllable, or as a *guna* to the vowel." The Persian alphabet may now be considered to be completely established. Of the thirty-nine letters which compose it, Major Rawlinson and Dr. Hincks are now agreed as to the values of all but one; Dr. Hincks having adopted three of Major Rawlinson's values, and Major Rawlinson having taken, independently, nine of those assigned by Dr. Hincks.

The data for the investigation of the Median, or second Persepolitan writing, are abundant, the trilingual inscriptions of Persepolis and Behistun furnishing more than ninety proper names, together with their Persian equivalents. Notwithstanding this, the progress made in the investigation has been comparatively small. In fact, with the exception of Grotefend, who made the first step, Westergaard is the only writer who has attempted the task of deciphering it with success. Major Rawlinson, indeed, informs us, in his Memoir on the Persian character, that he has made considerable progress in deciphering the two other kinds of Persepolitan writing; and he has given a sketch of his views on the orthography, and the general structure and affinities of the language of the second kind: but none of his results, as to the values of the characters, have been as yet published.

Westergaard held that the Median alphabet had six vowels and sixteen consonants; and that the characters represented, first, these twenty-two *letters*, and then *syllables* composed of the consonants followed by vowels. Dr. Hincks maintains, on the contrary, that there are but four vowels and five consonants; and that, besides the characters representing these nine simple sounds, there are also characters representing combinations of the five consonants with *preceding* and *following* vowels, as also combinations of the vowels with each other. Again,—while according to Westergaard the vowels are not all expressed,—according to Dr. Hincks every vowel is expressed at least once, and often more than once; it being customary to write vowels *twice over*, at the end of one character and at the beginning of the next. In accordance with this principle, Dr. Hincks adds vowels, in many cases, to Westergaard's values, thus making the characters to represent *syllables* instead of letters. Notwithstanding these important differences, however, he confirms, in general, the values given by Westergaard, although he differs from him altogether as to five of the characters, and assigns values to five more, which that writer had not valued at all.

But it is upon his labours connected with the third Persepolitan writing that Dr. Hincks's chief claim as an original discoverer must be founded. Grotefend discovered that the characters, in this writing, were partly expressive of syllables, and partly of letters; to a few of them, also, he assigned phonetic values; and he ascertained the fact of the correspondence of certain lapidary with certain cursive characters. To this little has been added by the many archæologists who have written upon the subject, beyond the mere *classification* of the characters. At an early period of his inquiries, Dr. Hincks arrived at the conclusion that the Babylonian and Assyrian writing agreed with the second Persepolitan in many of the features of the latter already noticed. The chief of the materials upon which he has since laboured are the Achæmenian inscriptions published by Westergaard, and the great inscription of the East India Company, containing 619 lines of lapidary characters. His first step in the deciphering of these documents was, of course, to analyse the proper names which occur in the third columns of the trilingual inscriptions, and to compare them with their equivalents in the other two. The values of many characters were thus determined; those of others were ascertained by comparing different modes of writing the same words in the inscriptions which commence with the same formula; and, finally, when the equivalence of two sets of characters, lapidary and cursive, was ascertained, more values were determined by comparing the proper names in the great inscription with their representatives in the other languages. By such means Dr. Hincks has constructed an alphabet, or syllabary, of the third Persepolitan writing, containing the values of ninety-five characters, together with the corresponding lapidary characters; and he has given a series of numbers from the rock inscription at Van, exhibiting the mode of expressing numerals in cuneatic characters.

Before I take leave of this subject, one more remark is necessary. It has been assumed by every writer who has hitherto engaged in the investigation of the cuneiform inscriptions, that the writing of the second and third kinds (as well as that of the first) is alphabetical. This fundamental position, however, has been recently assailed by Dr. Wall, in a very able critical paper read before the Academy; and arguments of much weight have been adduced to distinguish the principle of these two kinds of cuneiform writing from that of the first, and to prove them to be ideagraphic. It is not my duty (even if I were competent to the task) to offer any opinion upon the question thus raised. I have only to observe that what has been said above, respecting the progress recently made in deciphering these two kinds of writing, is based upon the ordinary assumption, and must be received with the reserve which necessarily attaches to a controverted position.

With Mr. O'Donovan's archæological labours I regret to say that I possess no direct acquaintance; and, accordingly, in the present notice of them, I am compelled to lean upon the friendly aid of the Secretary of the Academy, who is himself a large contributor to the same department of literature.

Mr. O'Donovan's vast acquirements connected with Irish archæology may be traced, in a great measure, to his connexion with the Ordnance Survey. In the course of the duties which this connexion imposed upon him, he visited every part of Ireland for the purpose of tracing the ancient names of places, and of collecting the local traditions connected with them, all of which he compared with the existing records in the historical manuscripts preserved in the Libraries of the Academy and the University. The object of these inquiries was to collect materials for the Historical and Antiquarian memoirs, which it was the original intention of the enlightened officers at the head of the Irish Survey to compile and publish,—an intention which (as the Academy are aware) was unhappily frustrated by the interference of Government. In the researches in which Mr. O'Donovan was thus for many years engaged, he acquired the vast amount of historical and topographical knowledge which his subsequent writings have displayed. He availed himself of the same opportunities to perfect his acquaintance with the dialects of the Irish language; and he has thus been enabled to throw a light on this department of philology, such as probably no other could have done.

The works edited by Mr. O'Donovan for the Irish Archæological Society are the first of his published labours which claim our attention. They are the following:

1. "The Circuit of Ireland, by Muircheartach Mac Neill, Prince of Aileach. A Poem written in the Year 942, by Cormacan Eigeas, Chief Poet of the North of Ireland."

2. "The Battle of Magh Rath (Moira), from an ancient Manuscript in the Library of Trinity College, Dublin."

3. "An Account of the Tribes and Customs of the District of Hy-Many, commonly called O'Kelly's Country, in the Counties of Galway and Roscommon. Edited from the Book of Lecan, in the Library of the Royal Irish Academy."

4. "An Account of the Tribes and Customs of the District of Hy-Fiachrach, in the Counties of Sligo and Mayo. Edited from the Book of Lecan, in the Library of the Royal Irish Academy, and from a copy of the Mac Firbis Manuscript in the possession of the Earl of Roden."

Mr. O'Donovan has also edited the following minor pieces in the Miscellany of the Irish Archæological Society, viz.: "An Ancient Poem attributed to St. Columbkille;" "The Irish Charters in the Book of Kells;" "A Covenant in Irish between Mageoghegan and the Fox;" and "The Annals of Ireland from A. D. 1453 to 1468. Translated from a lost Irish original, by Dudley Firbisse."

These historical tracts and bardic tales are edited, for the most part, in the original Irish, with translations and notes. In the latter Mr. O'Donovan has brought together a vast body of historical and genealogical information connected with the ancient families referred to; and he has illustrated the subjects with much curious antiquarian lore, respecting the manners and customs of the times. He has also, in many cases, annexed maps of the districts described, and topographical indexes, in which the etymology of the ancient names is given, together with the corresponding modern appellations.

Among the works of Mr. O'Donovan enumerated by the Council, in awarding him the Cunningham Medal, is his Irish Grammar. This work was undertaken for the use of the senior classes in the College of St. Columba, and was published at the expense of the Trustees of that institution. The publication has supplied a want long felt by the philologers of Europe; and the Celtic student is now in possession of a Grammar, compiled by a scholar who has studied the ancient language as it exists in our manuscript literature, and whose judgment and learning have enabled him to discriminate between the original and characteristic grammatical forms, and the accidental peculiarities belonging to particular districts or periods. The vast body of examples which Mr. O'Donovan has collected from Irish MSS., in illustration of this work, contributes greatly to enhance its value.

But Mr. O'Donovan's principal work is his edition of the Annals of the Four Masters, from the autograph manuscript in the Library of the Royal Irish Academy. The publication of this curious and important chronicle had been long and earnestly desired by Irish scholars. The language in which it is written was fast becoming obsolete, and another half century would probably have interposed a serious difficulty in its interpretation; while the curious mass of information which Mr. O'Donovan has brought together in illustration of it,—collected, as it has been, in a great part, from oral traditions,—would, in all likelihood, have been wholly lost. This work will ever remain a monument of the learning and labour of its author, and would suffice alone to place his name in a high rank in the list of Archæologists. The three large quarto volumes which have already appeared contain the Annals from A. D. 1172 to 1616; Mr. O'Donovan is now engaged in preparing for publication the earlier portion, which will be accompanied by a complete index of the names of persons and places mentioned in the Annals.

Upon the conclusion of his Address, the President presented the Medal to Sir William Hamilton, and addressed him as follows:

Sir William Hamilton,—in awarding you this Medal, the Council cannot have the gratification of feeling that they are contributing to the reputation of a name which is already known wherever Science is cultivated. But they trust that you will value it as a mark of sympathy from the Society, whose scientific character you have raised by your labours, and whose interests you have done so much in other ways to promote. Suffer me, on my own behalf, to add, that the duty which I now discharge, as the organ of the Academy on the present occasion, is to myself, personally, the most grateful of any which have devolved upon me as your successor in this Chair.

The President then presented the Medal to Mr. Haughton, addressing him as follows:

Mr. Haughton,—Accept this Medal as a testimony of the high value which the Council of the Royal Irish Academy set upon your researches, connected with a most difficult branch of Applied Mathematics; and as an expression of their hope that the labours in the application of the higher branches of analysis to physical problems, for which you have proved yourself so eminently qualified, and which have been already crowned with such success, may long continue to add to your own honour, and to that of the Academy of which you are a member.

The President, presenting the Medal to Dr. Hincks, addressed him thus:

Dr. Hincks,—Accept this Medal as a proof of the high opinion with which the Council of the Royal Irish Academy regard your researches, connected with some of the most obscure and difficult problems of Archæology. Allow me to add, that the merit of those researches, high as it is in itself, is enhanced in your case by the circumstance, that they have been pursued in the seclusion of retirement, and without any of those aids derived from the intercourse with others engaged in similar pursuits, which are usually so effective in impelling to and suggesting inquiry.

The President, presenting the Medal to Mr. O'Donovan, addressed him thus:

Mr. O'Donovan,—Accept this Medal as a testimony of the high value which the Council of the Royal Irish Academy set upon your labours connected with Irish philology, and Irish history and antiquities. This is the first occasion on which the Council, acting on the laws recently enacted by the Academy, have conferred the honour of the Cunningham Medal for works not published in the Transactions of the Academy. They therefore hope that you (and through you the literary public) will receive this award, not only as a just tribute to the value of your own researches, but also as a token of their sympathy with all who are engaged in the common pursuit of truth.

Mr. Robert Ball, Treasurer, presented an ancient silver pin of a very peculiar form, on behalf of John Mac Donnell, M. D. He also exhibited a large collection of casts of fossils, lately presented to the Museum of Trinity College by the East India Company.

The following communication on the dynamic effect of a turbine, as shown by the application of Prony's brake, was received from the Rev. T. R. Robinson, D. D.

This wheel was constructed for William Kirk, Esq., by the Messrs. Gardner, of Armagh. These gentlemen had been strongly impressed with the advantages of this wheel, by reading the account of it given by Sir Robert Kane, in the "Industrial Resources of Ireland;" and one of them actually visited France for the purpose of establishing relations with its inventor, which might enable them to introduce it as a moving power in this active manufacturing district. Finding it impossible to make any satisfactory arrangement with M. Fourneyron, they instituted a series of experiments, guided by which they succeeded in constructing the present machine, which seems to be very efficient; and as little is known in this country of the turbine, Dr. Robinson thinks the results he obtained may have some interest.

It drives eight beetling engines. In these a series of wooden stampers are raised by wipers on a revolving beam, and allowed to fall on the linen, which is rolled on a massive cylinder, sixty times in a minute, the cylinder itself revolving slowly, and being traversed in the direction of its axis. Each engine has thirty-six, weighing each twenty pounds and lifted twelve inches. The supply of water is very limited, being derived from the tail race of a mill situated higher on the water-course, and very deficient in summer; while in winter there is much back-water.

The turbine (a distinct idea of which can easily be obtained from a work of Rühlman, recently translated by Sir Robert Kane) has thirty-six floats, which are perpendicular to the circumference at their origin, and receive the water at an angle of 45°. These are attached by flanches, which, in Dr. Robinson's opinion, present a good deal of resistance to the efflux of the water, and absorb power. The internal diameter is 2·40 feet, and the external 4·80; the depth is 7·5 inches, divided into four compartments, which can be worked partially, and each of which can drive two engines.

In estimating the dynamic effect of a water-wheel, we must know the impelling power, and the resistance overcome with a given speed. The first is the weight of the water expended in a given time, multiplied by the height through which it has descended; this involves the measurement of the water, which, in Dr. Robinson's experiments, was made by an overfall established immediately below a bridge about 100 feet from the turbine. This process gives very precise results, if the necessary precautions be taken. The formula for the number of cubic feet passed in a second is $Q = C \times L \times \overline{H}|^{\frac{3}{2}}$, when C is a coefficient varying from 3·550 to 3·206, according to the ratio of the overfall's width to the channel in which it is placed. The first belongs to the case when they are equal, the second when that ratio does not exceed 1 to 3. L is the breadth of the overfall in feet, and H the depth of the water in it. This should be measured so far behind it as to be exempt from the curvature assumed by the surface as the water rushes towards the aperture. The measures were taken, for convenience, at the overfall itself, and it was found by trial that they require to be multiplied by 1·111, in the circumstances of this overfall, to reduce them to those due to the undisturbed surface. This formula, however, assumes that the water-way above is so large, that the velocity of arrival at the overfall is insensible. If not, the result must be multiplied by $\sqrt{\left(1 + \frac{0 \cdot 1395 \times u^2}{H}\right)}$; u being this velocity, which Dr. Robinson obtained by dividing the approximate quantity of water given by the formula, by the water-way of the channel. This last was found, by a careful section, to be 12·18 feet + $\frac{7}{8}$ of a foot for every inch of water in the overfall. The results obtained are, he believes, quite as exact as direct measurement could afford. The fall was ascertained by measuring, at the beginning and end of each experiment, the distance of the upper surface of the water below a point fourteen feet above the top of the turbine, and also the depth of water over that top (the wheel being always submerged). The power of the fall is expressed in horse power, whose unit is 33,000.

The resistance in ordinary work is, first, the friction of the machinery, and secondly, the weight of the beetles; these he at first thought could easily be valued, and thus give a measure of the efficiency of the machine. As, however, the beetles spring up by their own elasticity and that of the linen, and are overtaken by the wipers in their ascent, their whole weight does not resist. Indeed Dr. Robinson is not aware of any unexceptionable mode, except Prony's brake, which can exhibit the actual amount of actual force transmitted by a machine. This instrument is well known to consist of a ring clamped on a revolving cylinder, and tightened till its friction constrains the shaft to revolve at a given speed. That friction must equal the resistance of any other kind of work which produces the same speed; and it can be directly measured by weights hung on the extremity of a lever attached to the ring. Let R be the distance of the weight from the centre of the shaft, r the radius of the brake, n the revolutions which it makes in a minute, W the weight applied + that of the lever reduced to the same distance R; w the friction produced by the ring and its appendages. Then the effect is expressed by the equation.

$$E = \frac{2\pi r \times \left\{ \frac{W \times R}{r} + w \right\} \times n}{33{,}000}$$

In this instance $\frac{R}{r} = 19$, and $r = 0{\cdot}56$. The weight of the lever reduced to $R = 50$ lbs; and as the pressure of the brake, &c., = 202 lbs, while, from the abrading nature of the action,* the coefficient of friction must have been at least one-fifth, the quantity w may be taken at 40 lbs. These give the formula

$$E = (w + 52{\cdot}132) \times n \times 0{\cdot}002015.$$

In the first trial, the weight $W = 280$lb.; the depth on the overfall = 4·75 inches; the mean depth from the datum plane above, 15·75 inches; and that on the turbine thirteen inches, the water being dammed up by the overfall. The brake made nineteen revolutions in seventy-five seconds, equivalent to 70·1 of the turbine, or 23·59 of the wiper beam, per minute.

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* This was so severe, owing to the rubbing surface being too small, that it was necessary to have the upper part of the brake made a cistern, which was kept full of water, and communicated with the rubbing parts by several apertures. The water boiled violently from the heat evolved.

Hence Dr. Robinson computed

$$Q = 9{\cdot}41\ ;\ \text{Power} = 12{\cdot}38\ ;\ E = 10{\cdot}17\ ;\ \text{and}\ \frac{E}{P} = 0{\cdot}821.$$

The last number, the ratio of the work done to the power, is evidently the measure of the value of the machine, and though it is very high, Dr. Robinson is confident that it is not overrated.

The second trial was intended to observe the effect of a higher speed, and showed a remarkable diminution of effect. There $W = 224$lbs.; $H = 5{\cdot}125$ inches; the depth above 11·75 inches; that on the turbine the same as before; and the speed nineteen in sixty-six seconds, equivalent to 79·6 of the turbine, or 26·81 of the wiper beam. These data give:

$$Q = 10{\cdot}59\ ;\ P = 14{\cdot}43\ ;\ E = 9.61\ ;\ \text{and}\ \frac{E}{P} = 0.667.$$

At a third experiment the brake came off the shaft, but, fortunately, without doing any harm to the workmen; and Dr. Robinson did not think it prudent to replace it. He, however, hopes to repeat these trials, with a brake of larger dimensions, on another turbine that is in process of construction.

The great loss of effect by increasing the speed induced Dr. Robinson to suspect that some error must have occurred; but Mr. Kirk had observed that, by varying the number of engines, and counting the revolutions in each case, more work seemed to be performed at slow speeds. This was tried with the addition of the same overfall, to ascertain the power expended in each trial, and the results obtained, though not absolute measures, appear to Dr. Robinson worthy of notice, as they may assist the theory of these machines. The measures of the power, however, differ from the preceding, as the depth on the turbine was not measured. Instead of it, the depth at the overfall is deducted: this is less than the truth, and therefore the powers given are something too high.

The experiments were made thus. One compartment of the turbine being opened, the beetles of all the engines were suspended, and the revolutions of the wiper beam, per minute, counted. The resistance here is merely the friction of the gearing of the eight engines, $= g$. Then bring one set of beetles into action, the resistance is $g + \varepsilon$, and so on. Repeat the same with two and three compartments. With one, however, only four engines could be worked, and with the others it was thought unsafe to try g alone. The results obtained are given in the following table, of which the last column alone requires explanation. It contains the resistance in terms of g and ε, multiplied by a coefficient which is the number of revolutions divided by the power, or that which a unit of horse power would produce.

No.	Revol.	Compartments.	Fall.	Q.	P.	E	$= g \times$
1	26·30	1	12·40	6·36	8·94	$2{\cdot}943 \times g$	2·943
2	23·20	1	12·45	5·76	8·12	$2{\cdot}856 \times (g + \varepsilon)$	3·812
3	17·63	1	12·14	5·55	7·64	$2{\cdot}308 \times (g + 2\varepsilon)$	3·854
4	16·56	1	12·20	5·55	7·68	$2{\cdot}157 \times (g + 3\varepsilon)$	4·324
5	12·20	1	12·04	5·71	7·79	$1{\cdot}565 \times (g + 4\varepsilon)$	3·661
6	32·14	2	12·08	12·53	17·15	$1{\cdot}874 \times (g + \varepsilon)$	2·502
7	30·00	2	11·94	12·22	16·53	$1{\cdot}815 \times (g + 2\varepsilon)$	3·031
8	27·93	2	12·15	11·69	16·09	$1{\cdot}736 \times (g + 3\varepsilon)$	3·480
9	25·42	2	11·93	11·74	15·87	$1{\cdot}602 \times (g + 4\varepsilon)$	3·748
10	22·48	2	11·67	11·30	14·95	$1{\cdot}504 \times (g + 5\varepsilon)$	4·022
11	19·72	2	11·42	11·04	14·28	$1{\cdot}381 \times (g + 6\varepsilon)$	4·156
12	17·29	2	11·46	11·23	14·59	$1{\cdot}185 \times (g + 7\varepsilon)$	3·963
13	14·00	2	11·35	11·15	14·36	$0{\cdot}975 \times (g + 8\varepsilon)$	3·587
14	32·88	3	11·69	17·67	23·41	$1{\cdot}405 \times (g + 3\varepsilon)$	2·817
15	30·93	3	11·65	17·56	23·17	$1{\cdot}335 \times (g + 4\varepsilon)$	3·123
16	28·00	3	11·25	16·65	21·22	$1{\cdot}319 \times (g + 5\varepsilon)$	3·528
17	26·35	3	11·29	16·89	21·60	$1{\cdot}220 \times (g + 6\varepsilon)$	3·671
18	24·24	3	11·30	16·50	21·13	$1{\cdot}147 \times (g + 7\varepsilon)$	3·836
19	20·86	3	10·92	15·85	19·62	$1{\cdot}063 \times (g + 8\varepsilon)$	3·911

The effect of the speed is evident by comparing, for example, Nos. 4, 8, and 14, where the load is the same number. However, when it is equal, the effect per horse power must be the same. By equating the values of E, under this condition, the relation of g and ε may be determined. Thus, Nos. 16 and 8 gave

$$1{\cdot}319\ (g + 5\,\varepsilon) = 1{\cdot}736\ (g + 3\,\varepsilon)\ ;$$

from which

$$\varepsilon = g \times 0{\cdot}3240.$$

The mean of eight such* gives it $= g \times 0{\cdot}3349$ with no very great discordance; and substituting this value in E, the numbers given in the last column of the table are the result.

Taking means of those that are adjacent, and arranging them according to the revolutions of the turbine, per minute, they give:

Mean of	Revol.	Effect.
Nos. 3, 13	38·9	3·624
4, 12, 3	51·0	4·035
11, 19, 10	62·4	4·030
2, 18	70·4	3·824
9, 17	76·9	3·709
8, 16	83·0	3·504
7, 15	90·5	3·077
6, 14	96·6	2·654

It seems from this that the maximum effect is produced when it makes about fifty-four revolutions per minute; and that the effects at the speeds which correspond to those of the brake experiments are nearly in the same ratio.

Some practical results may be deduced.

1. The close approximation of the values of $\frac{\varepsilon}{g}$ shows that

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[*] When the speed is not exactly the same, interpolation is used.

the machine is equally efficient with one or several compartments open. It is least with the higher speeds, and *vice versâ*, as might be expected from the elasticity of the beetles being more active in the former case; but there is no difference which cannot be explained by this cause.

2. The quantity of water discharged in these experiments is scarcely more than half what is due to the head and water-way of the sluice. This was entirely unexpected; for in Barker's mill and other *reactive* wheels of the same kind, the centrifugal force increases the discharge; and nearly half the whole power is thus absorbed.

From the drawing of this turbine supplied by Messrs. Gardner, it appears that the effective water-way of the sluice, with three compartments open,* is 1·86 feet. From this and the column 2, the velocity with which the water enters the turbine can be computed; and Dr. Robinson finds that when the speed is seventy-two revolutions it enters *without shock*, a condition considered by Poncelet and others, who have treated of this wheel, to be essential. Here, however, the maximum is at a much lower velocity; from which it may be inferred that the theory of the turbine requires in this respect some modification. On the other hand, if Rühlman's details and plate of the St. Blas turbine (the most remarkable that has yet been constructed) are exact, it deviates from this rule far on the other side, revolving with more than twice the speed due to this condition. It seems, therefore, that the theory of the turbine requires some revision.

On the whole, Dr. Robinson is of opinion that the turbine is a very valuable motive agent, even should it not fully realize the highest statements of its efficiency which have been made on the Continent. He has not yet been able to compare it directly with the ordinary water-wheels, for the brake could not be applied without much inconvenience in any of Mr. Kirk's other mills; nor can any inference be made from the power applied to drive them, for the friction, &c., differs too much in each. For instance, measuring the quantity *g*, the friction of the machinery of eight engines, it was in that belonging to the turbine 4·74 horse power, when working at the normal speed; 3·45 at another mill; and only 2·82 at a third. That of the beetles is probably equally variable. But he sees no reason for doubting the results obtained with the brake, the lowest of which is scarcely exceeded by the best overshot wheels, while the others surpass considerably the usual estimate of their performance. The small bulk and weight are decided advantages (except in variable resistances, where the momentum of a large wheel acts as a fly). It seems peculiarly applicable to very high falls, having the special advantage of lessening in size and cost as the fall increases; and its power of acting with undiminished effect, when totally submerged, fits it for many situations where ordinary water wheels are impeded at times by back-water.

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* At the time of these experiments the permanent supply of water was only ten cubic feet, which will explain the diminution of fall as they proceeded.

NOVEMBER 13TH, 1848.

REV. HUMPHREY LLOYD, D. D., PRESIDENT, in the Chair.

THE Secretary read the following communications relative to recent antiquarian discoveries; one, a letter from Mr. Richard Young of Island-bridge, accompanying specimens of ancient Danish weapons, discovered by the workmen in excavating near the Terminus of the Great Southern and Western Railway. They consisted of a sword, much larger than has been yet found, and a smaller weapon of the same kind, together with an iron spear or pike-head, and a number of iron arrow-heads. The writer stated that he is about opening a gravel pit, which, it is supposed, may contain skeletons and antique remains. There were also presented an iron Roman sword, found in a cemetery at Treves, and an ancient urn, dug out of an old wall recently thrown down at St. Audoen's Church, together with some old coins, sent by the Rev. James Howie. A fragment of woollen fabric, worn by the ancient Irish, was presented by Sir Erasmus Burrowes of Lauragh, near Portarlington.

A vote of thanks was passed to the contributors of these interesting specimens.

Captain Larcom, V. P., having been called to the Chair, the President read a Paper "on the Corrections required in the Measurement of the Magnetic Declination."

The chief source of error in the measurement of the magnetic declination is that which arises from the torsion of the suspension thread. The angle of torsion appears to be altered, not only by the winding up of the suspension thread, which is occasionally necessary, but also by every removal of the magnet itself, the fibres of which the thread is composed appearing to re-arrange themselves when the suspended load is withdrawn. It is also subject to changes, although to a much smaller extent, arising from hygrometric variations in the atmosphere. It is important, therefore, that we should possess a simple and accurate method of determining its amount.

Let us conceive, with Gauss,* two horizontal diameters of the suspension thread,—one at the lower extremity, parallel to the magnetic axis of the suspended magnet, and therefore moveable along with it; the other at the upper extremity, parallel to the former in the state of detorsion. The angles contained by these lines with the magnetic meridian being denoted, respectively, by u and v, the angle of torsion is $v-u$; and the moment of the force of H torsion is $(v-u)$, H being a constant coefficient. This is resisted by the earth's magnetic force, the moment of which is $mX \sin u$, or mXu, *q. p.*, the angle u being small; and therefore the equation of equilibrium is

$$H(v-u) = mXu.$$

Hence

$$v = \left(\frac{mX}{H} + 1\right) u.$$

The value of the coefficient, $\frac{mX}{H} + 1$, is determined experimentally, by observing the readings of the scale attached to the magnet, corresponding to two positions of the arm of the torsion circle connected with the upper extremity of the suspension thread. Let v_1 and v_2 denote the values of v in the two positions; u_1 and u_2 the corresponding values of u; then denoting the coefficient for abridgment by p,

$$v_1 = pu_1, \quad v_2 = pu_2.$$

Whence, subtracting and dividing,

$$p = \frac{v_1 - v_2}{u_1 - u_2};$$

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* *Intensitas Vis Magneticæ Terrestris ad mensuram absolutam revocata.*

in which $v_1 - v_2$ is the angle contained between the two positions of the arm of the torsion circle, and is therefore known; and $u_1 - u_2$ is the difference of the observed scale-readings converted into angular value.

The value of $u_1 - u_2$, in this expression, must be corrected for the actual changes of declination which take place in the interval of the two readings; or else the observations must be instituted in such a manner as to eliminate, of themselves, these changes. The former course is that recommended by Gauss, and usually followed, the actual changes of declination being determined by simultaneous observations with an auxiliary apparatus. But in this, and in all similar cases in which the interval of the observations is small, the effect of such changes may be eliminated with more certainty by repeating the readings alternately in an opposite order for a few successions. Thus the errors arising from a want of exact correspondence either in the movements, or in the times of observing the two instruments, are avoided.

In order to determine the deviation of the plane of detorsion, v, the coefficient p must be altered, so as to change the value of u, while that of v is unchanged. The usual course adopted for this purpose is to diminish the magnetic moment, m, by substituting a weaker magnet. The value of the altered coefficient is to be determined experimentally in the manner already described: let it be denoted by p', and let u' be the new angle which the magnetic axis forms with the magnetic meridian. Then δ denoting the angle which the magnetic axis of the second bar forms with the lower diameter of the suspension thread, the angle of torsion is $v - u' + \delta$; and the equation of equilibrium is $v + \delta = p'u'$. Eliminating v between this and the original equation,

$$p'u' = pu + \delta.$$

Now δ is a small angle, of the same order of magnitude as u

and u', and may therefore be neglected in comparison with pu and $p'u'$. Hence, approximately,

$$p'u' = pu.$$

But, if a and a' denote the angles which the magnetic axes of the two magnets form with the line of collimation of the observing telescope, supposed fixed,

$$u' - u = a' - a;$$

and eliminating u' between this and the preceding equation, the error in the position of the magnet is

$$u = \frac{p'(a' - a)}{p - p'}.$$

Finally, the error of the plane of detorsion is

$$v = \frac{pp'(a' - a)}{p - p'}.$$

The angles a and a' are given by the formulæ

$$a = k(n - n_0), \quad a' = k'(n' - n_0');$$

n and n' denoting the actual readings of the scales of the two magnets, and n_0 and n_0' the readings corresponding to the zero-points.

It appears that the method above described, in which the value of p is altered by the substitution of a weaker magnet, is only approximate. But a much weightier objection to it is, that the plane of detorsion, and therefore the angle v, is liable to be altered by the removal of the magnet; and thus the assumption upon which the value of that angle is inferred fails altogether.

It is easy to avoid both these sources of error. It is obvious that the value of p may be diminished by increasing H, as well as by diminishing m; and that the effect upon the angle u will be the same in both cases. Now the torsion coefficient, *H*, may be increased without removing the magnet, simply by loading it with an additional weight, care being of course taken that the total weight is within the limit which the thread is capable of sustaining. The method is simpler, and easier in practice, as well as more accurate than the received one; and if the position of the magnet, when loaded and unloaded, be observed for several alternations, and in rapid succession, the result may be obtained with very great precision. The difference of the angles, $a' - a$, is, in this case, simply the difference of the observed scale-readings reduced to angular value; or,

$$a' - a = k\,(n' - n).$$

The following are the details of a series of observations made according to this plan. The last columns in the following Tables contain the differences between each reading, as given in the second columns, and the mean of the preceding and subsequent readings. The additional weight was 10 oz., being about one-half the weight of the magnet itself and its appendages.

Obs. I.			Obs. II.		
Magnet.	Reading.	Diffs.	Magnet.	Reading.	Diffs.
Unloaded	81·9		Unloaded	90·9	
Loaded	80·6	– 1·65	Loaded	88.3	– 1·9
Unloaded	82·6	– 2·0	Unloaded	89·5	– 2·4
Loaded	80·6	– 2·65	Loaded	85·9	– 2·4
Unloaded	83·9	– 2·4	Unloaded	87·1	– 2·0
Loaded	82·4	– 2·35	Loaded	84·3	
Unloaded	85·6				
Mean diff. = – 2·21			Mean diff. = – 2·18		

Hence $n' - n = -2{\cdot}20$; and $a' - a = k\,(n' - n) = -1'{\cdot}58$.

In determining the values of *p* and *p'*, the arm of the torsion circle was turned forwards and backwards, alternately, through two circumferences, and the scale-readings noted after each change. The following are the results:

I. Magnet unloaded.

$$v_1 - v_2 = 720°\,;\ \ u_1 - u_2 = 29'{\cdot}31.$$

II. Magnet loaded.

$$v_1 - v_2 = 720°\,;\ \ u_1 - u_2 = 43'{\cdot}43.$$

III. Magnet unloaded.

$$v_1 - v_2 = 720°\,;\ \ u_1 - u_2 = 29'{\cdot}22.$$

Hence we have

$$p = 1477\,;\ \ p' = 995\,;\ \text{and}\ \frac{p}{p'} = 1{\cdot}484.$$

Accordingly $u = -\,3'{\cdot}28$; and $v = -\,80°\,45'$. The values of u deduced from the *separate* observations differ only by $0'{\cdot}04$.

In order to determine the effect of hygrometric changes on the torsion of the suspension thread, a weaker magnet was attached; and the air within the box was alternately moistened to saturation by wet sponges, and dried by chloride of calcium, great care being taken to render the box air-tight. The position of the magnet was observed at an interval of some hours after each change; and the actual changes of declination were, under these circumstances, eliminated by the help of simultaneous observations with an auxiliary apparatus. Finally, the observed changes were reduced in the ratio of the magnetic moments of the two magnets. The partial results presented considerable discordance, notwithstanding every care in the observations; but the final mean is probably not remote from the truth. It gave,—as the total effect upon the position of the magnet, produced by the transition from complete dryness to complete saturation,—a change of $+\,1'{\cdot}0$, which corresponds to a change of position of the plane of detorsion of 24½ degrees. The greatest change (from its mean state) in the humidity of the atmosphere is probably about one-half of the total range; so that the limit of error of declination due to this cause may be considered to be $0'{\cdot}5$.

It will, of course, be understood that the effect here stated is that produced on the individual thread; and it is given merely as an example of the amount of error to be expected under ordinary circumstances. If the separate fibres which compose the thread were perfectly parallel, and equally strained, we have no reason to suppose that the changes of moisture would produce any change of torsion.

The next subject which claims our attention is the disturbance produced in the position of the magnet by the action of the other magnets of the Observatory, or by any other extraneous magnetic forces. The course which has been pursued at the Dublin Magnetical Observatory in determining the effect exerted by other magnets is very simple, and admits of the utmost precision. It consists in *reversing* the acting magnet (or turning its magnetic axis through 180°), and observing the new position of the magnet acted on; the difference of the two positions is *double* the error sought. In fact, the moment of the force exerted by the former magnet upon the latter is

$$\frac{mm'}{2D^3}\,\{\sin(\phi+\phi') - 3\sin(\phi-\phi')\};$$

in which m and m' denote the magnetic moments of the two magnets, D the distance of their centres, and ϕ and ϕ' the angles which their magnetic axes form with the joining line.* The value of this quantity is unaltered, although its sign is changed, when $180° + \phi$ is substituted for ϕ; and, consequently, the disturbing effect is *equal* and *opposite* to that produced in the original position of the acting magnet.

It is scarcely necessary to advert to the advantages of this course over that which is sometimes adopted, and which consists in the *removal* of the acting magnet. The change produced is doubled, and therefore the effect of errors of observation halved; and the two parts of the observation may be made at a very short interval,—an essential condition of accuracy in the elimination of the irregular changes. If the observations be repeated six or seven times in rapid succession, and at a time in which the irregular changes are small, the final result may be depended on to a few hundredths of a minute.

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* Trans. Royal Irish Academy, vol. xix. p. 163.

The following observation may serve as a favourable example of the accuracy attainable by this process. It was made to determine the effect of the action of the magnet of the balance magnetometer upon that of the declinometer, the two magnets being in the plane of the magnetic meridian, and the distance of their centres nineteen feet. The third column contains the differences of the corresponding readings in the second column, and the means of the preceding and subsequent readings.

North end.	Reading.	Differences. (N − S)
North	51·37	
South	51·78	− 0·46
North	51·28	− 0·49
South	51·76	− 0·47
North	51·30	− 0·47
South	51·78	− 0·49
North	51·28	
	Mean =	− 0·48

Hence the error = − 0·24 scale divisions = − 0′·17.

This process cannot be employed when the disturbing action is that of a mass of soft iron, and we must, in that case, have recourse to the less accurate and less easy method of removal. The following will serve as an example of the mode of dealing with such cases.

A considerable portion of the iron railing, now erected on the wall in Nassau-street, had been, previously to its erection, and during the absence of the writer in the summer, laid down in a horizontal position in the College Garden, at the southern side of the Observatory. The several pieces of which the railing is composed (each fourteen feet in length, and containing twenty-eight bars) were found placed in a continuous line parallel to the south walk of the garden, and forming an angle of 59° with the magnetic meridian. This line extended from a point nearly opposite the Observatory to a distance of 255 feet, and was distant from the declinometer magnet, at the nearest point, by 153 feet. It would, of course, have been impracticable to remove this great mass of iron, and to replace it rapidly, or for many alternations. Instead of this, the effect of a *single* piece of the railing was observed at a nearer distance, from which, and from the known laws of the mutual action of magnets, the total effect was deduced by integration.

Let a denote the perpendicular from the centre of the moveable magnet upon the line of the bars; and let α be the angle which that perpendicular makes with the magnetic meridian. Then, in the expression already given for the moment of the force exerted by a fixed upon a moveable magnet, $\phi + \phi' = \alpha$, and the moment of the force exerted by a single bar is

$$\frac{mm'}{2D^3}\{\sin\alpha + 3\sin(\alpha - 2\phi)\},$$

m being the magnetic moment of the bar, and m' that of the suspended magnet. The moment of the force exerted by an element of the railing whose length is dx, is obtained by multiplying this by ndx, n being the number of bars in the unit of length. This is equilibrated by the earth's magnetic force, whose moment is

$$m'Xdu,$$

du being the change of position produced by a single element of the railing; so that we have

$$Xdu = \frac{mn}{2D^3}\,\{\sin\alpha + 3\sin(\alpha - 2\phi)\,dx\}.$$

But

$$x = a\tan\phi,\quad dx = \frac{a\,d\phi}{\cos^2\phi},\quad D = \frac{a}{\cos\phi};$$

and substituting, and integrating,

$$Xu = \frac{mn}{2a^2}\int\{\sin\alpha + 3\sin(\alpha - 2\phi)\}\cos\phi\,d\phi$$

$$= \frac{mn}{4a^2}\,\{4\cos(\alpha-\phi) + \cos(\alpha - 3\phi) - \cos(\alpha+\phi)\},$$

and between the limits $\phi = 0$ and $\phi = \beta$,

$$Xu = \frac{mn}{2a^2}\left\{4\sin\left(\alpha - \frac{\beta}{2}\right)\sin\frac{\beta}{2} + \sin(\alpha-\beta)\sin 2\beta\right\}.$$

The value of mn in this expression was obtained, as before stated, by observing the effect of a single piece of railing in a known position. For convenience of calculation, this piece was placed upon the perpendicular let fall from the centre of the magnet upon the line of the rails, the bars being parallel to their original position. In this position $\phi = 0$; and therefore the moment of the force exerted by a single bar, at the distance D, is

$$\frac{2mm'}{D^3}\sin\alpha;$$

so that, if ε denote the disturbance produced by a portion of the railing, whose length is unity, in this position,

$$X\varepsilon = \frac{2mn}{D^3}\sin\alpha.$$

Finally, dividing the former result by this, mn and X are eliminated, and we have

$$u = \frac{D^3\varepsilon}{4a^2\sin\alpha}\left\{4\sin\left(\alpha - \frac{\beta}{2}\right)\sin\frac{\beta}{2} + \sin(\alpha-\beta)\sin 2\beta\right\}$$

The piece of railing which was the subject of experiment was raised, by the help of a windlass and pulleys, into the horizontal plane containing the magnet, and was fixed in the required position at the distance of 60 feet. The position of the magnet being observed, the mass of iron was lowered, and removed to a sufficient distance upon a truck, and a fresh observation taken. This process was repeated several times in rapid succession, and a series of observations thus taken, with the magnet alternately disturbed and undisturbed. The following are the results :

Time.	Railing.	Reading.	Difference.
$12^h\ 45^m$	present,	60·30	
12 53	removed,	58·12	+ 2·08
1 0	present,	60·10	+ 1·80
1 7	removed,	58·48	+ 2·02
1 13	present,	60·90	+ 2·08
1 20	removed,	59·15	+ 1·86
1 25	present,	61·12	+ 1·90
1 32	removed,	59·30	

These observations are very satisfactory. They give, for the mean difference of the readings due to the presence of the railing, + 1·96 divisions of the scale = + 1′·41. Hence the length of the piece of railing being 14 feet, the effect produced by a piece whose length = 1 foot, is

$$\varepsilon = + 0'{\cdot}101.$$

But $D = 60$, and $a = 153$, the unit of length being 1 foot. Also $\alpha = 31°$; and the length of the line of railing being 255 feet, $\beta = \tan^{-1}(1{\cdot}67) = 59°$. Hence the quantity within the brackets, in the value of u, is equal to $- 0{\cdot}363$; whence finally,

$$u = - 0'{\cdot}164.$$

The only other disturbing causes, in addition to those already noticed, are those which affect the position of the reading telescope. Upon these it is unnecessary to dwell. The changes of position are to be determined by referring the telescope, from time to time, either to a distant fixed mark, or to a fixed collimator. In the Magnetical Observatory of Dublin, the telescope of the transit instrument is used as a collimator, and thus the position of the reading telescope is referred immediately to the astronomical meridian.

Sir Robert Kane laid before the Academy some specimens of the series of maps now being prepared in the Museum of Irish Industry, illustrative of the distribution of the values of land in Ireland. The principle of the construction of these maps was described by Sir Robert Kane to consist in the reduction of the numerical results of the Government valuation of Ireland, now in process of publication, under the direction of Mr. Griffith, to such system of classification, indicated by characteristic colours, as would show the manner in which the soils of different financial values are distributed over the country. The specimens laid before the Academy comprised two sets of maps, of which the one showed the registered valuation of townlands; the second, the values of groups of townlands reduced to an average of value. The method employed was the following. Sir Robert Kane, having found by consultation with experienced agriculturists that the unit of difference of value might be taken as sufficiently small for practical purposes at two shillings per statute acre, reduced the values of townlands to a scale of ascending rates, from zero to thirty-six shillings per acre, and then, having transferred to the county index maps of the Ordnance Survey the boundaries of townlands, which are engraved only on the maps of the six-inch scale, those are coloured with tints respectively indicative of the values, and thus a pictorial representation of the distribution of the different classes of land is obtained. As the map so formed becomes, however, very detailed, the number of tints very numerous and very much intermingled, and hence, although rendered necessary by the investigations as to the nature of soils with which Sir Robert Kane is occupied, it was important also to present a more general view of the distribution of those classes of soils, which would embrace a large range of values, and constitute, in fact, a generalization of the former, or map of detail. For this purpose, the system of colourings employed in the detailed map had been based upon the use of groups of colours; thus, the really waste lands, as from value zero to two shillings, being marked in Indian ink, the class of inferior lands were all indicated by various tints of brown; the class of medium soils were indicated by various shades of green and yellow; the class of superior soils with various tints of blue and purple; and, finally, the class of soils whose values are above thirty-two shillings are practically found to derive their advantages more from artificial and local circumstances than from intrinsic constitution, and these are all coloured with tints of red. The different classes of land are thus indicated by five typical tints:

Black, ...	Waste lands.
Brown, ...	Soils of inferior value.
Yellow, ...	Soils of medium value.
Blue, ...	Soils of superior value.
Red, ...	Soils of factitious value.

The indications thus obtained are very illustrative of the several influences on which the practical values of soils depend. The elevation above the sea, the proximity of towns, the direction of great roads, evidently determining, together with the chemical constitution of the soil and the geological character of the locality, the practical result on which the financial value depends.

Sir Robert Kane was led to the construction of these maps from his anxiety to obtain a term of comparison for the fertile value, as deduced from the chemical composition of the soils which are now being analysed in the laboratory of the Museum of Irish Industry, under his direction. He has fully recognised that the chemical composition of a soil will indicate its power to supply the materials necessary for the growth of plants, but its practical fertility will depend also on other mechanical and meteoric conditions; and to eliminate these, and to estimate their relative influences, Sir Robert Kane found that it would be highly valuable to contrast, under the form of maps, the chemical constitution of the soils of the several districts, and their relations to climate, with the practical standard of value as given by Mr. Griffith's official valuation, the conversion of the numerical estimates of which into a visible and pictorial representation has been the principle of construction of the maps now laid before the Academy.

Professor Oldham called the attention of the Academy to the importance of connecting the geological structure of a country with all such inquiries as regard the distribution of soils of different value. The county of Wicklow—a soil map of which, coloured from Mr. Griffith's valuation, Sir Robert Kane had exhibited—was one which well illustrated this; and as the geological map of that county, just published by the Geological Survey, had been presented to the Academy on that evening, a reference to it would shew the very remarkable connexion which existed between the occurrence of certain geological deposits, and the existence of soils of certain values. On this map, *for the first time*, the more recent geological deposits—the marls and gravels—of Wicklow, were represented, in addition to the more solid geology of the district. This was accomplished by using for these recent and more superficial deposits an engraved tint, independent of, and in addition to, the conventional colours adopted to represent the different groups of soils. Now, a reference to this map would at once show that all that portion of the map which, on Sir Robert Kane's map, represented by his colours the soils of high values, was exclusively confined to that portion which, on the geological map, was included under this engraved tint, or in which these more recent deposits of marl, &c., occurred In several cases, Professor Oldham stated, on preparing the maps separately, and comparing them, it was found that the boundary line marking the limits of these soils of higher value, as given by the townland valuation of Mr. Griffith, was also for miles found to be the boundary line marking the limits of these recent deposits. Mr. Oldham also remarked how erroneous any view of the distribution of soils of various money values would be, derived from a consideration of these values, as deduced from a valuation by townlands. The money value per acre being obtained by dividing the number of acres in the townland into the estimated value of the whole townland, an average value per acre may be obtained, and represented on the map, which will give a very mistaken view of the distribution of soils in that townland. Several cases of this also occur in the county of Wicklow, where whole townlands of considerable size should, as deduced from the townland valuation, be represented by a colour giving an appearance of much higher money value per acre than the adjoining townlands; this erroneous appearance arising simply from the occurrence of richer soils in some very limited portion of such townland, which, thus taken with the remainder of the townland, gives a higher average, and, therefore, a mistaken view of the distribution.

These views afforded a strong confirmation of the general relative accuracy of Mr. Griffith's valuation. And if the valuation by holdings (and not by townlands) were complete, a still more valuable and important comparison might be instituted. It appeared, however, desirable to notice these points, even in the present stage of the inquiry, as most of the soils on which Sir Robert Kane had experimented had been procured by the officers of the Geological Survey of Ireland, under Mr. Oldham's directions.

Sir Robert Kane observed, in explanation of the above remarks, that he could not at all admit the coincidence Professor Oldham asserted between the deposits marked on the geological map, and the lands of highest value depicted on the map of Sir Robert Kane's construction. It is true there exists along the east coast of Wicklow a quantity of clays and marls, and the lands in that locality are of superior value; but it is at once seen that these lands are situated all along the great line of intercourse from Dublin to Wexford, and that they group round the principal towns of Bray, Wicklow, and Arklow, as centres, showing that, although certain geological materials must be present as the fundamental basis for the agricultural value of a district, the financial value, in practical cases, is specially determined by the influence of economic and social causes. This is peculiarly shown by the relations of the western side of the same county, where it is seen that the values are quite independent of the recent deposits marked on the geological map, the highest values grouping themselves round the towns, and localities occupied by recent geological deposits being, in many cases, estimated as of the inferior degree of value. The valuation map of Kildare is also peculiarly useful in showing this, as the great lines of western and south-western traffic are prominently displayed by the greater value of the lands along them, and also the higher money price of the land round towns is similarly shown; but this arrangement of the values does not connect itself, in any intimate degree, with the differences of geological character which that county is known to present.

In regard to the objection that the unit of valuation being a townland, and that, in a townland consisting partly of bad and partly of good land, the average value might be incorrect for each, Sir Robert Kane remarks, that the instances of those irregularities are very rare, and do not affect the result, as they disappear in the second class of maps, where the groups of values are united to frame a classification adapted to practice.

Finally, Sir Robert Kane remarked, that Professor Oldham was somewhat obscure in stating that the soils are collected under his direction, to be examined by Sir Robert Kane. The collection of soils is being made by direction of the Chief Commissioner of Woods, upon the application of Sir Robert Kane, and the specimens are obtained in the several localities by the officers of the Geological Survey, as the most convenient mode of procuring them.

The thanks of the Academy were voted to Sir James Dombrain, for his kindness in undertaking to effect the transmission, from Dingle to Dublin, of a collection of Ogham stones, presented by Mr. Hitchcock to the Museum of the Academy.

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November 30th, 1848.—(Stated Meeting.)

REV. HUMPHREY LLOYD, D. D., President, in the Chair.

The Chevalier C. C. J. Bunsen, of Berlin; C. J. Thomsen, of Copenhagen; and P. E. Botta, of Paris; were elected Honorary Members of the Academy in the department of Antiquities.

The Rev. Dr. Robinson read a communication on the relation between the temperature of metallic conductors and their resistance to electric currents. After referring to the researches of Sir Humphrey Davy and others on the same subject, he described and exhibited the instrument used in his experiments, and gave a concise sketch of the mathematical investigations based on them, which led him to the following conclusions.

When a wire of platina is heated by a voltaic current, its resistance to the passage of that current increases with the heat up to the verge of its fusion. This increase of resistance is not caused by the increased density of the current, by the increased distance of molecules, or the employment of molecular force in generating heat; but is exactly proportional to the temperature. The same is the case with copper wire, and the amount of change bears in both the same ratio to the original resistance. This change should be attended to in all measures of resistance.

The heat generated by a current is as the product of its square into the *actual* resistance, but that attained by a wire ignited in air as the square root of this product.

The cooling power of air is, *in these experiments*, as the temperature; that of radiation as its square.

A wire thus ignited is dark at the two extremities, but the temperature rapidly rises as the distance from them increases, and soon becomes uniform over a large extent of the wire.

Its thermic equation shows that this uniform temperature exceeds the mean by an amount varying from a seventh to a tenth.

The Rev. Dr. Robinson next proceeded to notice a fact of some interest which he lately observed with the Rosse telescope. It related to a remarkable planetary nebula, Herschel's figure 44. This looks, in smaller instruments, like an oval disc, reminding one of the planet Jupiter; but it appears to be a combination of the two systems which he had formerly described. In both these the centre consists of a cluster of tolerably large stars: in the first, surrounded by a vast globe of much smaller ones; in the other by a flat disc of very small stars, which, when seen edgeways, has the appearance of a ray. Now this nebula, which he had recently observed through Lord Rosse's telescope, has the central cluster, the narrow ray, and the surrounding globe. He would also add, as a remarkable proof of the defining power of this vast instrument, that he saw with it, for the first time, the blue companion of the well-known γ Andromedæ, distinctly, as two neatly separated stars, under a power of 828. It was discovered by the celebrated Struve, with the great Pulkova Refractor, and is a very severe test. He further wished to mention that, as La Place had anticipated, the ring of Saturn, which was quite visible, showed irregularities, which are most probably mountains, on its eastern side.

The President expressed the high sense which he entertained of the value of Dr. Robinson's researches on so important a subject as electric conduction; and observed that the Academy must feel deeply indebted to Dr. Robinson for the valuable and interesting information which he had afforded them on that point, and also with regard to the nature of the *nebulæ*, as shewn by Lord Rosse's telescope.

The Rev. Dr. Robinson then read the following communication descriptive of the contents of an ancient bronze vessel found in the King's County, and now belonging to the collection of the Earl of Rosse. The antiquarian relics contained in this vessel comprised several celts, some spear-heads, gouges, and curiously constructed bells; they were composed of a beautiful hard bronze, in very fine preservation. The composition of the metal itself, and the style of workmanship evinced in the various articles, argued no mean degree of metallurgic skill in their fabrication. Several of those interesting relics were exhibited to the members; and drawings, which were pronounced to be admirable in their fidelity and minuteness, were displayed of the several implements of war and husbandry which were not exhibited.

"Several years ago, I remarked this vessel in the collection of the Earl of Rosse, and the singularity of its contents made me suppose a description of it might interest the Academy. I, however, found it impossible to acquire any information as to the locality or time of its discovery till now. It had been purchased for Lord Rosse, about sixteen years since, by an inhabitant of Parsonstown; but the men who had found it, with that strange suspiciousness that is such a peculiar feature of the Irish peasant, had made him promise to keep the details secret during their lives. The last of them died this winter, and then Mr. —— felt himself at liberty to give me this information. It was found in the townland marked Doorosheath in sheet 30 of the Ordnance map of King's County, near Whigsborough, the residence of Mr. Drought, in what appears from the description to have been a piece of cut-out bog, about eighteen inches below the surface. No river is near the spot; no bones or ornaments, or implements of any kind, were near it: though, had any gold or silver been discovered, the finders would probably not have acknowledged it to any one. I could not learn in what position it was found.

"A very good idea of the appearance of this vessel is given by fig. 1 of the accompanying drawing, for which I am indebted to Arthur E. Knox, Esq.[*] The scale is one-third of the original, and he has given very precisely the actual condition of its surface. It is composed of two pieces, neatly connected by rivets. The bronze of which the sheets are formed possesses considerable flexibility, but is harder than our ordinary brass; and it must have required high metallurgic skill to make them so thin and uniform. On the other hand, it is singular that, neither in this nor any other bronze implements with which I am acquainted, are there any traces of the art of soldering: if it might be supposed objectionable in vessels exposed to heat, yet in musical instruments this would not apply.

"Such vessels have often been found, but the contents of this are peculiar. When discovered (without any cover) it seemed full of marl, on removing which it was found to contain an assortment of the instruments which may be supposed most in request among the rude inhabitants of such a country as Ireland must have been at that early epoch. A few were given away, one of each, in particular, to the late Dean of St. Patrick's, and these are probably in our Museum; but the following remain:

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[*] This vessel is very similar to one in the Museum of the Academy, which is marked D. 551. As several of the other objects described by Dr. Robinson resemble the specimens contained in the Museum, a reference to the latter is given in each case.

"1. Three hunting horns, with lateral embouchure, shown on the scale of one-third at fig. 2 (D. 656).

"2. Ten others of a different kind, fig. 3 (D. 653): these differ considerably in size, but that represented is of the average size. Some of the largest have the seam united by rivets; in others it is marked by a paler line in the bronze, which seems as if they had been brazed, but is probably owing to a thin web of metal, which penetrated between the halves of the mould in which they were cast. All of this kind seem to have had additional joints, of which three were found, figs. 4 and 5 (B. 963); at least, no other use of these pieces occurs to me; and in none of them is there any convenient embouchure.

"4. Thirty-one bells of various sizes, figs. 6 (B. 945) and 7 being the extremes; of the real size. They have loose clappers within, and many of them slits to let the sound escape more freely. The bronze in these is much harder than in the preceding, and has resisted decomposition almost entirely. I think it can scarcely be doubted that these were bells for cows and sheep, which would be specially useful among the dense forests which then overspread the island.

"5. Thirty-one celts, of very different sizes, but none sufficiently large to induce a belief that they were used in war. In many of them the colour of the bronze is such as, at first sight, to excite an opinion that they were gilded. There are

Two of the size of fig. 8 (B. 244).
Seven of the size of fig. 9 (B. 347).
Six of the size of fig. 10 (B. 350).
Five of a size intermediate between these, and

Six of the size of fig. 11 (B. 270).

Five of the size of fig. 12 (B. 276).

"It is worthy of notice that in all the points are entire and sharp, and the edges unbroken, and not seeming to have been ever used.

"6. Three gouges, fig. 13 (B. 181). These are, I believe, of comparatively rare occurrence, and therefore were, probably, of less extensive use than the celts; just as the common carpenter's gouge is with respect to his chisel, to which I believe the others to have been the analogues. Their round edge is well adapted either for paring or for excavating bowls and goblets.

"But the finest specimens of workmanship are the spears, twenty-nine in number. These also are of various sizes, and of greater diversity of pattern than the other implements. There are

Two of the size of fig. 14 (B. 54).

Four of the size of fig. 15 (B. 38).

One of the size of fig. 16 (B. 35).

Seven of the same size, but a plainer pattern.

Nine of the size of fig. 17 (B. 34).

Six of a size two-thirds the preceding, but which it did not seem necessary to draw.*

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* It is a curious circumstance that *six* kinds of spear-heads should have been found. Dr. R. had met with seven different names for this weapon in Irish; but as his knowledge of this language is very limited, he availed himself of the high authority of Mr. Eugene Curry, who gives them :

Laighin, pronounced	Loy-en.
Sleagh, ...	Shle.
Manais, ...	Mon-eesh.
Cruiseach, . . .	Crusheach.
Fogha, ...	Fow-gha.
Gae, ...	Gaé.
Gaḃal, ...	Ga-val.

With the remark, however, that Sleagh and Gae are sometimes used indiscriminately. The Laighin was of foreign introduction, and peculiar to the

" These, also, have their points and edges perfect, and seem never to have been used; they show not only that the workmen who made them were perfect masters of the art of casting, but also that they possessed high mechanical perceptions. If these weapons and the bronze swords (of which our Museum contains several) be compared with those used in our army, it will easily be seen that the former are constructed on principles far more scientific. Some of these may not be obvious to the ordinary reader, as they depend on the properties of bronze. This alloy, especially when in the proportion used for weapons (in which it is an atomic compound, containing fourteen equivalents of copper and one of tin, or nearly eighty-eight and twelve by weight, and possesses a maximum specific gravity considerably surpassing either of its elements), combines great strength and toughness, but has not hardness to take an effective and permanent edge. It has, however, been shown by D'Arcet, that if its edge be hammered till it begins to crack, and then ground, it acquires a hardness not inferior to the common kinds of steel, and is equally fitted for cutting instruments. Now, in fig. 14, the strong central cone of bronze, remaining in its ordinary state, effectually stiffens the weapon against fracture; while the thin webs on each side have evidently been subjected to this or some similar process, for their edges are much harder, as well as brittle. In the smaller weapon, fig. 17, the web might be too thin, and,

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men of Leinster; it was, therefore, not likely to be used in this locality, so that the collection, probably, comprised all that were in demand. Among these names, four are evidently of Hebrew affinity. The second is identical with שלח (*shlech*), a missile spear; the third comes from מנה, fate; the fourth, or rather its abbreviate form, Cꞃuıꞇh, is from כרת (*chreth*), to destroy; the sixth is little altered from קין (*koin*), a dart; and the last, possibly, comes from גוב, to divide. Mr. Curry remarks, also, that several of these names are now given to agricultural instruments; the loy and slaine are familiar examples: Manaıꞃ now means a mason's trowel. It should seem that metallurgy was made the minister of war long before it became subservient to the arts of peace.

therefore, it is reinforced by a pair of secondary ribs; and in fig. 16, the most highly finished of them all, by four such. It is, however, possible that these ribs may have answered another purpose; they have so strong a resemblance to those on some Malay krises, that they may have been designed, as in those weapons, to retain poison. This practice, I fear, was not unknown among the ancient Irish, as, indeed, it seems to have prevailed among all the Celtic and Iberian races; thus, in the poem on the death of Oscar, published by Bishop Young, in the first volume of our Transactions, the spear of Cairbre is expressly said to be poisoned (Niṁe), and nothing seems to require a figurative sense of this epithet to be understood.

"The most obvious hypothesis respecting this curious assemblage of objects is, that they were the property of some individual, who concealed them in the bog, perhaps on the approach of a predatory party, and perished without recovering them. Against this is the fact that the tools and spears seem not to have been ever used, and the probability that, in such times, every spear-head would have been mounted, and in the hand of a combatant. It seems more likely that the collection was the stock of a travelling merchant, who, like the pedlars of modern times, went from house to house, provided with the commodities most in request; and it is easily imagined that, if entangled in a bog with so heavy a load, a man must relinquish it. And this is connected with another question, the source from which the ancient world was supplied with the prodigious quantities of bronze arms and utensils which we know to have existed. This caught my imagination many years since, and I then analysed a great variety of bronzes, with such uniform results, that I supposed this identity of composition was evidence of their all coming from the same manufacturers. Afterwards I found that the peculiar properties of the atomic compound already referred to are sufficiently distinct to make any metallurgist, who was engaged in such a manufacture, select it.[*] It also appeared to me more permanent in the crucible than when of higher or lower standard. But the same conclusion is forced on us from another ground. Bronze contains tin; now this metal, for all commercial purposes, may be said to be confined to the south-west of England,[†] and, therefore, the bronze trade must have originated with persons who were in communication with Britain. But in ancient history we find only one people of whom this can reasonably be supposed, the Phœnicians, who, like ourselves, seem to have been the great manufacturers and merchants in olden time. That they had factories, if not colonies, in Spain, at a very early period, is known to all; and it seems most unlikely that such enterprising navigators would stop there. Of course, one can attach little weight to the remote traditions of Irish history, if unsupported by other probabilities; but the traces of Phœnician intercourse which they exhibit are borne out by the admixture of Punic words in the language, and by usages which show that the worship of the god Baal, and other Sidonian rites, had once prevailed in the island. Their traffic in amber proves that they must have gone yet further, even to the Baltic; for then, we may be sure, the land carriage of precious materials through various and hostile regions was almost impossible. All, too, that we know of early antiquity shows that they had the bronze trade in their hands. Even down to the time of Aristotle, tin was described by the epithet 'Tyrian;' and in every nation where bronze was in common use, their presence can be traced or inferred. In Egypt, where this compound was of universal use, we know that the people were little addicted to maritime pursuits; while they were in close communication with the Sidonians (of the same race), through the Mitzräite colony of the Philistines. In Etruria, not less remarkable for its profuse employment of bronze, we know that they did not obtain it directly, for it is recorded that an expedition was fitted out by them, to open a communication with the tin islands, which failed, in consesequence of the jealousy of the Phœnicians. Hence we may conclude that the latter held a monopoly of the tin. In Judea, we find Solomon obliged to employ a Tyrian founder for the bronze works of the temple, and we gather from the account, also, how they were cast—in loam.* But Greece, in the Homeric age, presents a state of things much more conformable to what I suppose was the condition of Ireland when this collection was buried. Iron scarcely appears to be in use; and it may be surmised that the art of working bronze itself was not generally understood, from the poet's description of Vulcan making the arms of Achilles. No mention is made of casting or moulds, though a reference to Milton's splendid description of the infernal palace shews how much more poetic that would have been than the hammer and anvil. It seems as if the god merely heated and chased into shape sheets of metal, already prepared.† It may be added, that Homer describes all articles of superior workmanship as Sidonian; and represents this people as trading in every part of Greece. Their ships run into some cove, and their factors go to the dwellings of the neighbouring chiefs. These, though at feud among themselves, and driving each other's cattle on every opportunity, receive the strangers kindly, and purchase from them hardware, jewellery, articles of dress, and toys, in return for cattle and slaves. Now, just such a person I suppose the possessor of this vessel to have been, and of this very nation. Commerce was probably carried on in this way along the shores of the Mediterranean, till the destruction of Tyre by Nebuchadnezzar destroyed it also for a time, and then removed its most powerful centre of action to Carthage. That state seems to have chiefly directed its attention westward; and it is a confirmation of my opinion that the bronze trade was almost exclusively Phœnician, that about this time the use of the alloy rapidly gave way to iron and steel. In fact, the supply being cut off from Greece and Asia by the ruin of the Tyrians, *they* were obliged to seek other resources; but in Ireland and other Atlantic lands the traffic must have continued, nay, perhaps, even increased, in consequence of that event, till the fall of Carthage finally cut it off. I would also throw out another suggestion, though at considerable risk of being thought a dreamer. We see in Homer that the Phœnician traders were quite ready to have recourse to violence when they could profit by it; and, from more historic sources, that, in Lybia and Spain, they took an early opportunity of turning their factories into forts, and enslaving the natives. Did the same thing happen *here*, when the Tuatha De Danaan, a tribe rich in metallic ornaments and weapons, subdued the ruder Firbolgs, who referred their superior knowledge to magic? Were these shadowy personages also Phœnicians? Their name signifies "the tribe of the gods of the Dani or Damni." If the first, it might indicate Odin and his Asæ; but, besides that *they* must have been far later, it seems highly improbable that such fierce warriors would have been overpowered by any Celtic immigration. If the second, the Damni, the inhabitants of Devonshire and Cornwall, must have been completely under the influence of the Phœnician agents, and may at first have imagined and called their accomplished visitors deities. In these Ogygian regions we must not reckon dates too closely; but I believe it is held that the battle of Moytura, which established their dominion, was fought about 600 years before our Lord, and, therefore, at the very time when the fall of Tyre may have been supposed to scatter its people, and the ruin of their commerce incline them to desperate adventure. It is possible that this conjecture may be established or disproved by a comparison of the skulls found in the sepulchral monuments on their battle-fields with those of Tyrian or Carthaginian origin, if any such are known to exist."

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[*] The technical importance of atomic proportions is remarkable. Speculum metal is $4\mathrm{Cu} + 1\mathrm{St}$; gong metal is $8\mathrm{Cu} + 1\mathrm{St}$; that referred to is $14\mathrm{Cu} + 1\mathrm{St}$; the hardest metal used for cannon is $16\mathrm{Cu} + 1\mathrm{St}$.

[†] There are tin mines in Malacca, but we have no evidence that they were worked so early; and if they had been, it is quite improbable that their produce found its way to the Mediterranean.

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* Moulds for celts have been found here and in other countries, but were, perhaps, employed to recast old bronze; they could not turn out work very neat, and many of these tools have apparently been cast in sand. These spears were, I think, cast in loam.

† Bronze is brittle at a red heat; but it and even bell-metal are malleable at a temperature below visible ignition. Speculum metal is not brittle while red hot.

Dr. Petrie made some remarks on the different characters of the bronze found in different counties in Ireland, and on the manner in which bronze articles were anciently cast.

The Rev. W. Roberts presented a memoir, by the Rev. Brice Bronwin, "On the Theory of the Planetary Disturbances."

In this memoir the disturbances are applied, as in M. Hansen's theory, and, as in it, are obtained by means of two times; but the author has pursued a totally different route from him in finding them. The fundamental equations are investigated in a way that leads to many very beautiful formulæ, some of which appear to merit further consideration, as enabling us to change the form of the disturbance function, and to effect many transformations of a similar character.

The memoir also contains a new fundamental equation, not noticed by M. Hansen, and which leads very conveniently to the determination of the arbitrary functions of τ, the constant time, in the integrals; moreover, these functions are presented under a much simpler form than that given by M. Hansen.

To determine the disturbances of the radius vector and longitude, with both the times, would be a work of immense labour. M. Hansen, therefore, in his lunar theory, has contrived to eliminate them, but by a process so long and complicated, that it is extremely difficult to follow him through the numerous transformations he has employed, and to see the reasons of them. This part of the theory is greatly simplified in the memoir, by developing only relatively to the quantities which it is our object to get rid of: we can develope with reference to the other quantities equally well, and even with advantage afterwards. The developments in question are effected with regard to the powers of the disturbing force, and not in series of sines and cosines.

It is easier to find the radius vector and longitude on the plane of the orbit than by referring the motion to a fixed plane; but it is a matter of more difficulty to find the latitude in this case. In this part of the theory the author has introduced changes which may be employed very advantageously when the inclination is small. The inclination (i) and the longitudes (ϑ and θ) of the node on the two planes produce many terms in the disturbance function. In place of these quantities, the latitude and reduction (the two sought quantities) are, in the memoir, introduced into this function, and into its partial differential coefficients. Afterwards $\sin i$ and $\sin (v-\theta)$ are obtained, instead of the three quantities, ι, θ, ϑ, or p, q, and $\vartheta-\theta$, which M. Hansen finds. Thus, the latitude is found as readily as when the motion is referred, in the first instance, to a fixed plane.

The memoir concludes with a transformation of the differential equations from a fixed to a sliding plane, preserving a constant inclination (that of the orbit) to the fixed plane, and sliding upon it with a uniform motion, equal to the mean motion of the node. No details are added here; the transformation is merely noticed as appearing to merit further consideration.

Rev. W. Roberts read a paper, from which the following is an extract.

" In a note communicated some time since to the Academy, I extended to the system of any hyperbola and its conjugate a property of the equilateral hyperbola, and the lemniscate derived from it, given by Mr. Talbot, in the fourteenth volume of M. Gergonne's *Annales de Mathématiques.* The result at which I then arrived I have since found to be a very particular case of a curious and general theorem, which may be enunciated as follows:

" *Being given a hyperbola, the equation of which is*

$$\frac{x^2}{a^2}-\frac{y^2}{b^2}=1,$$

where a is supposed greater than b, let the curve be described, which is the locus of the feet of perpendiculars dropped from the centre upon its tangents: from this new curve let another be derived, and so on, by repeating continually the above-mentioned construction, and let S_n *denote the perimeter of the* n^{th} *curve of the series. Also, let* Σ_n *be the perimeter of the* n^{th} *curve, obtained by a similar mode of generation from the conjugate hyperbola,*

$$\frac{x^2}{a^2}-\frac{y^2}{b^2}=-1.$$

Then, any combination of these perimeters, such as

$$S_{2i}\,S_{2i+1}+\Sigma_{2i}\,\Sigma_{2i+1},$$

will be expressible by elliptic functions of the first two kinds in the following manner:

$$S_{2i}\,S_{2i+1}+\Sigma_{2i}\,\Sigma_{2i+1}=\pi\{\alpha+\beta\mathrm{F}(k,\phi)+\gamma\mathrm{E}(k,\phi)\},$$

where

$$k^2=\frac{a^2}{a^2+b^2},\quad \cos\phi=\frac{b^2}{a^2},$$

and where α, β, γ, *are algebraic functions of a and b.*

" *The foregoing equation holds for the case of* $i=0$, *by supposing that* S_0 *(or* Σ_0*) expresses four times the difference between the infinite hyperbolic arc and its asymptote.*

" It is evident that we may give a purely geometrical enunciation to the above theorem. For let s denote the arc of the hyperbola,

$$\frac{x^2}{a^2} - \frac{y^2}{b^2} = 1,$$

measured from the vertex to the point of which the ordinate (y) is $\sqrt{(a^2 - b^2)}$; and let s' be the arc of the ellipse,

$$\frac{x^2}{a^2 + b^2} + \frac{y^2}{b^2} = 1,$$

counted from the extremity of the lesser axis to the point of which the ordinate is $\frac{b^3}{a^2}$; and we will have

$$S_{2i} S_{2i'+1} + \Sigma_{2i} \Sigma_{2i'+1} = \pi \{\alpha + \beta s + \gamma s'\},$$

α, β, γ, being, as before, algebraic functions of a and b.

"By making $i = i' = 0$, we light on the theorem which I formerly communicated to the Academy. In this case γ, in the last equation, vanishes.

"The above theorem, which I think there would be some difficulty in establishing directly, I have demonstrated very simply, by employing the method of elliptic co-ordinates, with the vast power of which, as an analytical instrument, all readers of the mathematical publications of the present day must be familiar. I subjoin a sketch of my proof, which, I trust, may not be altogether uninteresting.

"In the first place, I calculate the values of S_{2i}, $S_{2i'+1}$, Σ_{2i}, $\Sigma_{2i'+1}$, by means of a general formula which I obtained some years since, and which has appeared in the Proceedings of the Academy. Then, after a few easy transformations, I am enabled to write the sum of the two products, $S_{2i} S_{2i'+1}$ and $\Sigma_{2i} \Sigma_{2i'+1}$, as a double definite integral, which, although consisting of a variety of terms, is found ultimately to depend on two only, which are distinct and independent. Of these, one expresses the superficial area of a certain ellipsoid, and the other, the sum of all the superficial elements of the same ellipsoid, divided by the squares of the areas of the sections of the surface made by the diametral planes parallel to these elements. The reduction of these integrals to the normal form of elliptic functions may be effected in a variety of ways; the simplest, probably, is that given by M. Jacobi, for the rationalization of such integrals, in the tenth volume of Crelle's Journal.

"The combination, $S_{2i} S_{2i+1} + \Sigma_{2i} \Sigma_{2i+1}$, of the perimeters of the curves derived from conjugate hyperbolæ, which, as we have seen, admits of being put under such a remarkable geometrical form, has also a very curious signification in mathematical physics. This remark I owe to my distinguished friend, M. Liouville, who mentioned it to me in conversation a short time since."

December 11th, 1848.

REV. HUMPHREY LLOYD, D. D., President, in the Chair.

A collection of stone, bronze, and iron antiquities, with some casts of specimens in the Museum at Copenhagen, were presented by the Royal Society of Northern Antiquities.

The Rev. Dr. Todd (Secretary) directed the attention of the meeting to a highly interesting group of antique relics, which had been presented to the Academy by the Royal Society of Northern Antiquities at Copenhagen. He observed that those specimens were, some of them, analogous to antique remains of a similar character which had been found in Ireland, several of which were in the possession of the Academy. The existence of such an analogy between the weapons and instruments used in ancient times, by the inhabitants of this and more northern countries, was known to the Academy, and a small collection of antiques of this nature, found in Ireland, had been selected and transmitted by the Academy to the Northern Society, along with a large collection of drawings of the most characteristic specimens in the Museum of the Academy. A catalogue had been forwarded of the various specimens. He also observed that, in this kindly interchange, the Academy was doubtless the gainer; and he felt sure the members would agree with him in the propriety of passing a vote of thanks, on the part of the Royal Irish Academy, to the Society of Northern Antiquaries.

Dr. Petrie seconded the motion for a vote of thanks, and suggested the propriety of a similar vote to the King of Denmark, who was a zealous patron of antiquarian science in his own dominions, and must have concurred in the donation of the Northern Society. Dr. Petrie observed, that some of the articles sent were similar to specimens in the possession of the Academy; but there were many others, particularly among the stone weapons, to which nothing similar had yet been found in Ireland. The whole of this splendid present had been got together in a most kindly spirit towards the Academy. The Society of Northern Antiquaries went through their collection with great care, in order to select those articles which had reference to Ireland, and were likely to throw most light upon her ancient history. Some of the bronze swords which were contained in the present collection had the original bronze handles, in which the specimens found in Ireland were generally deficient; at least, he was only aware of three specimens having the original handles that had been found here; one of these was in his own collection, one belonged to the Academy, and the third was in the Museum belonging to the Royal Dublin Society. The handles in question were ornamented, and, from their rarity, were extremely interesting. When Dr. Petrie became a member of this Academy, he observed in one of the small rooms a number of valuable stone antiquities; and one of the first things he drew the attention of the Council to was the expediency of having them brought down stairs, and deposited in a place of security. The similarity of some of these articles, which were then supposed to be Irish, to specimens preserved in the Copenhagen Museum, had long been a subject of interest to our antiquaries; but he had recently learned, that those very articles were a present from the same Society of Northern Antiquaries, made to the Academy so long back as the year 1816, and hence a few of the finest of them are now added to the present donation. Dr. Petrie then particularized several of the other specimens contained in the collection recently presented to the Academy; one of these was a curious spiral armlet, which, he said, was of a class very rare in Ireland, the only one which he had ever seen in this country being in his own collection; the bronze collars, or *torques*, of a spiral pattern, were also of uncommon occurrence in Ireland, though so common in gold. The iron sword in this collection was also of great interest, as it was exactly similar to those found at Kilmainham and other parts of Ireland, and which were now claimed as Danish weapons.

The special thanks of the Academy were then given to His Majesty the King of Denmark, and the Society of Northern Antiquaries, for the above donation, and also for books* presented at the same time.

The President, in putting the vote of thanks, which was adopted unanimously, observed, that the example of the Society of Northern Antiquaries suggested to the members of that Academy a very desirable course, namely, to make casts and models of the various relics which belonged to their collection.

A translation of the catalogue of the antiquities presented was communicated by Mr. Peter Browne, Secretary to the British Legation at Copenhagen. It will be found in the Appendix.

The Rev. Dr. Todd then presented to the meeting some antique relics possessing considerable interest, which had been contributed to the Museum of the Academy. He exhibited a model of an ancient spear-head (the largest he remembered to have ever seen), sent to the Academy by —— Carruthers, Esq. The model was taken in lead, and was tinted so as to represent more accurately the original weapon, which is of bronze.

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* The particulars of this latter donation will appear in the list of presentations at the end of this volume.

Dr. Petrie proposed a vote of thanks to Mr. Carruthers, for this valuable model of a spear-head, which, Dr. Petrie was persuaded, was the finest specimen of the kind existing in Europe, as it was unequalled by any which had been discovered in Greece, Egypt, or any of the eastern countries.

The thanks of the Academy were voted to Mr. Carruthers.

Dr. Petrie next called the attention of the meeting to a cast of an inscription on a pillar-stone preserved in the grounds of Mr. Gordon, of Newton, near Pitmachie, in Aberdeenshire, and which Dr. Petrie presented to the Academy on the part of Patrick Chalmers, Esq., of Auldbar, near Brechin, at whose expense the cast had been made and forwarded. Dr. Petrie observed, that he had been induced to request this cast for the Academy in consequence of his having discovered, from a similar cast preserved in the Museum of the Royal Society of Scottish Antiquaries at Edinburgh, that the stone bore a second inscription, not previously noticed, which was in the Irish Ogham characters, and which he thought it desirable to bring under the notice of the Academy; the more particularly, as two or three specimens of the same class had been recently discovered in Wales. Unfortunately, however, this cast did not embrace the entire of the Ogham inscription; but the inscription which it did present perfectly was one of great historical importance, and of no less interest to the Irish than to the Scottish antiquary, as it may be assumed to belong to the Pictish people, whose early history is so intimately connected with that of the Irish, but whose origin is so involved in obscurity. This historical obscurity, which an interpretation of this inscription might remove, has been thus alluded to by Dr. Pritchard: "It may, perhaps, be impossible to settle the long agitated Pictish controversy; what those people were, whence they came, or why they were so called, were questions which, though frequently discussed, have never yet been accurately decided. Unfortunately, there are no remains of literature, not even a single sentence, and scarcely an ascertained word, preserved as a specimen of the language of the Picts."

Dr. Petrie, in conclusion, having expressed his hope that this inscription might find a successful interpreter in Ireland, proposed a vote of thanks to Mr. Chalmers, for his kindness in presenting the cast to the Academy.

The vote of thanks to Mr. Chalmers was passed.

The Rev. Charles Graves exhibited a drawing on a large scale of the inscription in the Ogham character which runs along the *side* of the pillar-stone at Newton. In consequence of its having been executed with less precision than is generally manifested in similar monuments found in Ireland, there is considerable difficulty in deciphering it; and, on this account, he was not yet prepared to submit his views respecting it to the Academy. A correct reading of the Ogham inscription is of the more importance, as a knowledge of its purport might help us to decipher that other inscription, on the *face* of the stone, of which Mr. Chalmers has presented the Academy with a cast, and which has hitherto defied all the efforts of antiquaries to ascertain either the language or the character in which it is written. Mr. Graves mentioned two circumstances which concur to render it probable that this latter inscription is in a character used by some of the Scandinavian people.

1. The posterity of Mac Duff, the murderer of Macbeth,

" were entitled to certain privileges, contained in a *Gothic* inscription engraved on a stone pillar."[*]

2. There occurs, in the inscription on the Newton stone, a character of very peculiar form, which appears in a Runic inscription figured by Goransson.[†] Unfortunately, that antiquary was obliged to leave the Runic inscription itself undeciphered, in consequence of several of the characters which are introduced into it being unknown.

Sir W. R. Hamilton gave an account of the application of the calculus of quaternions to problems respecting the construction of a circle touching three given circles on a sphere; and of a sphere touching four given spheres.

The Rev. Charles Graves laid before the Academy the following account of certain ancient Irish manuscripts in the possession of the Highland and Agricultural Society of Scotland.

" Being in Edinburgh for a few days last summer, I endeavoured to obtain access to the Irish manuscripts, which I had learned were deposited in the collection of the Highland Society. By the kindness of the Secretary, Mr. Hall Maxwell, I was allowed not only to see them, but to examine them at my leisure; and I now beg to submit to the Academy the following brief account of the contents of the more remarkable ones.

" At the period when the controversy respecting the authenticity of the poems of Ossian was at its height, the Highland Society undertook to collect oral and documentary evidence, with a view to throw light upon this vexed question. A vast mass of writings, most of them recent and of little value, but some of undoubted antiquity and importance, was thus brought together. The time at my disposal being very limited, I deemed it advisable only to attempt a cursory examination of the most interesting manuscripts. For this reason I confined my attention to those which were written on vellum, taking that circumstance as an indication of their greater age and value.

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[*] Johnstone's Lodbrokar Quida, p. 102.

[†] Bautil, p. 8, fig. 25.

" I. The first which I examined is marked X. in an 'Analysis' of these manuscripts made by Ewen Maclachlan. It consists of thirty-eight folios in all, but is made up of distinct portions written by different persons and at different times.

" 1. The first six folios contain what seem to be perfect copies of several ancient and curious historical romances relating to Conor Mac Nessa, Conall Cearnach, Oilioll and Meave, Fergus Mac Roich, Ceat Mac Maghach, Laoghaire Buadhach, Cealter Mac Uitheacar, &c. Imperfect copies of some of these tales are to be found in the Book of Leinster, a manuscript of the twelfth century, in the Library of Trinity College, Dublin. The names of the scribe, and of the person for whom the transcript was made, are given at the end of this tract, in a kind of cipher, which I read thus :

" Oroit sunn dfir in liubairsi .i. Eoin mac Eoin.
" Misi rodgreseir ⁊ Fergal ata comnaic.

" Mr. Curry tells me there was a scribe named Fergal, a Mac Egan, who lived about the year 1580, and has left memoranda in his handwriting on the margins of the Leabhar Breac, from which it would appear he was taking a transcript at the time.

" The writing of these six folios is throughout extraordinarily full of contractions.

" On the upper half of page 12 is some indistinct writing, in a different hand, which I did not take time to decipher.

" 2. On folio 7 commences an ancient Irish Life of St. Colum Kille, which occupies eight folios. The roundness of the handwriting, and other characteristics, induce me to believe that it may be as old as the tenth century. Unfortunately, no memorandum is attached, indicating the name or time of the scribe. This life of the Saint was unknown to Colgan, and seems to have formed the groundwork of the voluminous Life of Colum Kille, compiled by Magnus O'Donnell at the close of the sixteenth century, and highly prized by Irish antiquaries for the curious legends and interesting historical and topographical notices which it contains.*

"3. A piece of ten folios, containing: (*a*) A romantic tale relating to Goll, Connall Mac Ghlegais of Colptha, Cuchulann, &c.† (*b*) A copy of the Tain Bo Fraoich, a tale of a plunder of cows, brought over from Scotland by Fraoch, one of the Connaught heroes of the Tain Bo Cuailgne. (*c*) A tract entitled the Penance of Adam: a copy of this exists in the Leabhar Breac in the library of the Academy.

"4. Another piece of ten folios, in a different handwriting, commencing with the words

"Ri firen foirgliḋ ro ġabustar flaṫas ⁊ forlaṁus for Erinn .i. Ereṁon.

In this tract is given the story of Cuchulann's adventures at Teamhair Luachra, on the borders of Kerry and Limerick; a tale of uncommon interest, on account of the topographical references contained in it, and chiefly because it gives much insight into the manners and customs of the ancient Irish. Parts of it are preserved in the Book of Leinster, and in the Leabhar na Huidhre in our library; but these two fragments

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[*] Since making the above communication, Mr. Graves has ascertained that copies of an ancient Irish Life of Colum Kille, similar to the one here described, in their commencement and in the general arrangement of their matter, but apparently much less copious, are preserved in the Leabhar Breac and the Book of Lismore, both manuscripts in the library of the Royal Irish Academy.

[†] I am not aware that copies of these tales are to be found in any library in Ireland.

do not complete the piece. At the end is a note, indicating that this tract was transcribed in the year 1537, by Seanchan MacGilla Crist Mic Eoin. The scribe, out of a pedantry usual amongst persons of his class, disguises his name by using the letters *b*, *f*, *k*, *p*, instead of the vowels *a*, *e*, *i*, *o*.

"5. The volume ends with a piece consisting of four folios, written in a very old and singularly fine hand. I doubt if I have seen any Irish minuscule writing superior to it, except it be in the Book of Armagh. This piece contains: (*a*) An account of Cuchulann's courtship with Eimer, the daughter of Forgall Monach; also (*b*) a tract on the law for observing the Lord's day as a day of freedom. The composition of this tract is ascribed to the close of the eighth century or the beginning of the ninth; and certainly the Brehon law part of it, laying down the penalties consequent upon violations of the privilege of the Lord's day, is of great antiquity. There are copies of this most curious tract preserved in the MS. H. 2, 16, in the library of Trinity College, in the Leabhar Breac, and in a MS. in the British Museum; but there appears to be some imperfection about them all which a comparison with this one might supply.

"II. The Emanuel MS., as it is entitled by Astle,* consisting of seven folios and a half.

"It contains nothing but a narrative of events which occurred in the civil war between Cæsar and Pompey.

"At the bottom of page 4 is a note which I suspect indicates the age of the MS. Though nearly illegible at present, it appears capable of being revived by gallic acid. I could read ńo ꝺi. m^{ccc}.xu.; from which it would seem that the MS. is as late as the fourteenth century, though Astle assigns it to the ninth or tenth.

"It seems strange that a person so conversant with palæography as Astle should commit the error of deriving the title of this MS. from the word Emanuel, which happens to be written at the top of the first page. It was usual for scribes to place some sacred name at the top of a page, by way of hallowing the work which they were commencing. Thus we frequently meet 'Jesus,' 'Maria,' 'In nomine Sanctæ Trinitatis,' 'Amen,' &c.

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* See Astle's Origin and Progress of Writings, 2nd edit., p. 123.

"III. The Glen Masan manuscript, consisting of twenty-five large folios, written in double columns.

"In this are contained the story of the Sons of Uisneach, and a series of tales arising out of the wars consequent upon their death. It concludes with a copy of the *Tain Bo Flidais*, a tale of a cattle spoil connected with the *Tain Bo Cuailgne*. If this be a complete copy of the tale, it is of no small value. We have as yet seen only a fragment of it in the manuscript, H. 2, 16, in the library of Trinity College.

"On the first folio of the Glen Masan manuscript is a memorandum in a recent handwriting, which states that it was transcribed in the year 1238. Examining it hastily, as I did, I failed to discover any memorandum or signature of the scribe confirming this. The writing is not unlike that of the Book of Leinster, in the library of Trinity College, Dublin, which was written in the middle of the twelfth century.

"IV. A volume containing at its commencement a Calendar, written on vellum. It begins with directions for finding the dominical letter or golden number for any current Julian year. By the aid of an entry which states that there was a new moon at midnight, on the 26th of January, we may calculate the year for which this Calendar was intended.

"The scribe has signed his name in cipher. It appears to have been Diarmaid O Fioṫġiollaig. The remaining part of the volume is on paper. I noticed a copy of O'Duvegain's celebrated poem on the calendar, commencing

"Bliaġain ro solus a daṫ
"Slige aigeanta na nEolaċ.

"Before almanacs got into general circulation, it was not an uncommon thing to find persons in Ireland able to repeat the whole of this long poem by heart; and in all disputes relative to times and seasons, its authority was appealed to as decisive.

"The rest of the volume consists of medical tracts on paper.

"It was impossible for me, in the short time which I could spare for the work, to institute a more careful examination of these manuscripts. Still I deeply regret my having brought back so little knowledge of the contents of the Glen Masan manuscript, marked III. in this list. Having spent two days over No. I., I was obliged to content myself with a more cursory inspection of the rest. I came away, however, consoling myself with the prospect of seeing these manuscripts again; for I entertain a confident hope that, if an application were made by the Royal Irish Academy to the Highland Society of Scotland, requesting the loan of these manuscripts, it would meet with favourable consideration. The controversies concerning the Ossianic poems having terminated, any jealousies which once existed between the antiquaries of the two countries have died away; and no feeling actuates them but a desire to co-operate in the work of illustrating the closely related histories of the two countries. An opportunity of comparing the Edinburgh manuscripts with those which are preserved in our libraries here, would be attended with great advantages. We might thus copy what was unique, complete what was imperfect, and explain many things that are now unintelligible, by reference to more ancient and accurate texts."

IT WAS RESOLVED,—That the Council be requested to take steps to ask for a loan of the MSS. described by Mr. Graves.

JANUARY 8TH, 1849.

REV. HUMPHREY LLOYD, D. D., PRESIDENT, in the Chair.

VISCOUNT Dungannon, John Bell, Esq.; Rev. James Bewglass, LL.D.; Rev. Edward Dillon; John Carley, Esq.; Jonathan Pim, Esq.; John Purser, Esq.; John L. Rickards, Esq.; and Henry Smith, Esq.; were elected Members of the Academy.

Mr. Donovan read the first part of a paper "On the Deflections of the Magnetic Needle, producible by contact of Metals with each other, and by their attrition; with some observations on the applicability of these deflections to the purposes of telegraphic communication."

It is known that, under certain circumstances, some metals will, by contact, act on each other in such a manner as to produce a deflection of the magnetic needle, which will be reversed when, instead of contact, attrition is employed. The experiment is generally made with a mass of bismuth and a mass of antimony, each connected with the binding screws of a galvanometer. If these masses, *one held in each hand*, be brought into contact, the needle will be deflected; but if the masses be rubbed against each other, the needle will veer round perhaps to an equal degree on the opposite side of the magnetic meridian.

Professor Erman, of Berlin, who has bestowed much attention to the subject, thus sums up the opinions current upon it: "Some observers" (he says), "who appeal to the authortiy of Mr. Emmet, express what they consider to he the law of this action, by saying that thermo-electricity of contact is changed invariably into the opposite state by the friction of the metallic factors; others, on the contrary, deny *in toto* the influence of friction on the thermo-electric phenomena. Thus, it was recently adverted to in a scientific journal, as a highly paradoxical fact, that in a given case friction had caused a change of sign in the thermo-electric declination produced by the contact of two heterogeneous metals; but, at the same time, this 'unheard-of' fact, as it was called, was explained by supposing, gratuitously, that friction had been effected whilst keeping the metal to be rubbed in the naked hand, and in thus producing an accidental change of temperature. This explanation was offered on the assumption that friction, in itself, is not capable of producing any effect. Between the two extremes of tribothermo-electric omnipotence and nullity, I have tried to discover the middle course of truth."

Professor Erman then delivers his own opinions, and the facts from which he has deduced them: "A bar of bismuth was joined to that branch of the rheophore of this instrument (the galvanometer), where the silver of a voltaic element (silver and zinc) produces an eastern deviation, and a bar of antimony to the other branch of the rheophore. Both of these bars were provided with handles, so that they could be employed without undergoing any change of temperature in the manipulation. When, through these being stationed in the same room, the two bars had previously arrived at the temperature of the surrounding space, no deviation whatsoever was produced by their contact, but the slightest friction of either of them against the other gave immediately an eastern deviation. This latter extended even to an entire revolution of the needle in the same direction, if the friction proceeded rather more rapidly. By gently raising the temperature of the two bars to 100° or 111° Fahr., their contact in a state of repose always produced a stationary eastern deviation of about 30°, which, by rubbing, was further increased to 60°, and there likewise remained invariable as long as friction continued. At length, when I cooled the bars below the temperature of the room, by the evaporation of sulphuric ether, their contact continually produced a western deviation, which, by rubbing, was instantaneously changed into a contrary or eastern one, of apparently the same amount as before, and this likewise remained stationary as long as the friction continued; but by the interruption of it, the western deviation was immediately restored. This simple sketch of the phenomena of changes of intensity, or even of sign, which friction at the point of contact gives to the deviation of a multiplicator's needle, will already suffice to exhibit it as a mere consequence of the heat produced by the action of rubbing."

Mr. Donovan expressed his opinion that Professor Erman and the authorities to whom he alludes, have been deceived in their conclusions by their not having been in possession of a sufficient number of facts. After an examination of all the phenomena which had been discovered by himself and others in this department, Mr. Donovan stated his opinion that they are all dependent on the following eighteen general principles or laws, most of which have now, for the first time, been developed:—

I. The agent which causes the deflection of the needle of the galvanometer may be brought into action either by the attrition or thermo-contact of certain metals, metallic ores, or certain forms of carbon.

II. When two different metals, and sometimes separated masses of the same metal, are rubbed against each other, deflection will result, the degree and direction of which will vary with the metals employed, with the force and rapidity of attrition, and in some cases with the temperature. This deflection will take place in air, or under the surface of mercury, or of aqueous, oily, ethereal, or alcoholic liquids.

III. When two different metals, and sometimes two separate masses of the same metal, or even when two different parts of the same mass of metal, are brought in contact at unequal temperatures, deflection will take place, the degree being determined by the nature of the metals and the difference of their temperatures.

IV. If two different metals be at the same temperature throughout their mass, whether it be high, low, or mean, contact will not produce deflection.

V. (1). Sometimes the deflective energy, developed by attrition of two metals at unequal temperatures, is more effective than that produced by their contact when their temperatures are in a state of inequality to the same amount as that at which attrition took place. (2). And sometimes the deflective energy of two metals in contact, at unequal temperatures, is more effective than that developed by their attrition when their temperatures are in a state of inequality to the same amount. The result 2 is of less frequent occurrence than the result 1.

VI. The deflection producible by contact of two metals which are at unequal temperatures may be on the same side with, or on the opposite side to that producible by attrition of these metals when they are in a state of equality of temperature.

VII. When two metals at unequal temperatures produce deflection on the same side of the magnetic meridian, both by their attrition and contact, while, if their temperatures be equal, their attrition causes deflection on the opposite side of the magnetic meridian, it is an obvious consequence that the deflection caused by attrition or contact of the metals, while their temperature is unequal, will change to the opposite side of the magnetic meridian, if attrition be employed during the period of their approach to and arrival at equality of temperature.

VIII. If the two metals, being at unequal temperatures, produce by their contact a deflection on the side of the magnetic meridian opposite to that which attrition under the same circumstances affords, but synonymous with that which is produced by attrition when both metals are in a state of equality of temperature, then it is plain the deflection produced by such contact will be reversed by attrition of the metals while at such unequal temperatures.

IX. If the deflections be all on the same side of the magnetic meridian, which are produced, 1st, by the contact of the two metals at unequal temperatures; 2nd, by the attrition of the metals when they are at equal temperatures; and 3rd, by their attrition when they are at unequal temperatures: then there can be no reversal.

X. Whether the deflection of the needle will take place on the eastern or western side of the magnetic meridian will be determined by the nature of the metals engaged; by the *relative* temperatures at which contact or attrition has been effected; and by the peculiar influence of the metal that is placed in connexion with, and is active at each extremity of the coil of the galvanometer.

XI. The condition necessary to the production of deflection by contact of two different metals is, that heat shall be at that moment entering or leaving one of them, or that heat shall be unequally entering or unequally leaving both of them; no matter whether the inequality depend on difference of supply, of conduction, of capacity, or on unequal diffusion of heat arising from difference of mass of the metals, or on more than one or all of these causes conjointly. The deflection caused by the unequal entrance of heat into metals in contact will be on the side of the magnetic meridian opposite to that on which it would be, if heat were leaving them unequally.

XII. If a metal of a certain class be heated in one part, while the remainder of it is maintained at a much lower temperature; and if the hot part be brought in contact with a metal of a different class, which is at a much lower temperature throughout its mass, the deflection produced will be on the side of the magnetic meridian opposite to that on which it would have been if the first-mentioned metal had been equally heated in all parts. And it is possible to heat such portion of the first-mentioned metal, it being in contact with the second, as will balance or destroy the tendency to deflection on either side of the magnetic meridian; the needle will then hesitate near the zero, and there will be no decided deflection.

XIII. If two different metals, properly connected with the galvanometer, be placed in contact with each other at one point; and if a corresponding small portion of each be brought to an equal temperature, different from that of their respective remainders, they will produce deflection on the side of the magnetic meridian opposite to that on which the deflection would have *temporarily* taken place, had the metals been throughout their mass exposed to that temperature. If the portions of the metals acted on be raised above the temperatures of their remainders, the deflection will be on the side of the magnetic meridian opposite that to which the needle will be deflected, if these parts be reduced to a temperature below that of their remainders.

XIV. The deflection produced by thermo-contact or attrition will be always reversed when the exciting metals connected with the extremities of the galvanometer coil are transposed.

XV. When deflection is produced in consequence of the attrition or contact of two metals, one of which is adequately hotter than the other, the deflection will change to the opposite side of the magnetic meridian, if the hotter metal be cooled, and the cooler metal be adequately heated, the contact or attrition being continued as at first.

XVI. The deflection produced by the mutual attrition of any particular pair of metals will take place, at all temperatures of these metals, on the same side of the magnetic meridian, provided that the temperature be equal or nearly equal in both. As this direction of the needle is always the result of the attrition of these particular metals when they are in their ordinary state of equality of temperature, it may conveniently be called the *natural* deflection of any pair of metals; it is generally, but not always, more powerful than the deflection produced by thermo-contact.

XVII. The deflection caused by chemical action of a menstruum on two associated metals has no observable dependance on, or connexion with that produced by thermo-contact or attrition of these metals.

XVIII. The agent developed by the attrition of two metals, even when rapid, forcible, and long-continued, does not manifest any decomposing influence on chemical compounds, nor is it conducted by aqueous liquids, even when containing saline impregnations.

The President commented briefly upon Mr. Donovan's paper, noticing especially the labour and care which he had bestowed upon the investigation; at the same time he could not avoid regretting that the laws of the tribothermic phenomena had not been reduced to a smaller number, and to a simpler expression. The subject was one of very great interest and importance in a theoretical point of view; for it is in electrical phenomena of this class, if anywhere, that we may hope to gain an insight into the nature of the molecular agency upon which they are probably dependent, and thus to connect the science of electricity with other departments of physics.

The Rev. Samuel Haughton read a paper on the Laws of Propagation of Plane Waves in extended media.

In a paper read before the Academy, May 25, 1846, Mr. Haughton deduced the equations of solid and fluid bodies from the hypothesis that the molecular action is in the line joining the molecules, and that there is no action at right angles to that line. This hypothesis led to the conclusion that the function V, on which the internal forces depend, consists of six quantities;

$$\frac{d\xi}{dx},\ \frac{d\eta}{dy},\ \frac{d\zeta}{dz},\ \frac{d\eta}{dz}+\frac{d\zeta}{dy},\ \frac{d\zeta}{dx}+\frac{d\xi}{dz},\ \frac{d\xi}{dy}+\frac{d\eta}{dx};$$

the discussion of the properties of this function occupies the remainder of the former paper. As the six quantities used in this function are not the same as the three quantities used by Professor Mac Cullagh in his researches in Physical Optics,

$$\frac{d\eta}{dz}-\frac{d\zeta}{dy},\ \frac{d\zeta}{dx}-\frac{d\xi}{dz},\ \frac{d\xi}{dy}-\frac{d\eta}{dx},$$

Mr. Haughton was led to suppose that the laws of the optical medium were quite distinct from those of solid and fluid bodies; and that, consequently, the molecular action in that medium is of a more general character, and is not confined to molecular forces acting in the line joining the molecules. In the present paper Mr. Haughton shows that this *primâ facie* view of the subject requires some restriction, and that Professor Mac Cullagh's equations, so far as they belong to the *propagation* of waves, may be deduced from the simple assumption of forces in the line joining the molecules; while the equations containing the laws of *reflexion and refraction* cannot be deduced from any such hypothesis. The object of Mr. Haughton's paper is, however, more general, and includes the discussion of the laws of propagation of plane waves in bodies of the most complicated molecular structure; from which are deduced the laws of bodies whose molecular action is more simple, and consists of simple attractions or repulsions between the molecules.

In an indefinitely extended body, no external forces acting, the most general function for the internal forces will be

$$V=F(\alpha_1,\alpha_2,\alpha_3,\beta_1,\beta_2,\beta_3,\gamma_1,\gamma_2,\gamma_3);$$

where

$$\alpha_1=\frac{d\xi}{dx},\quad \alpha_2=\frac{d\xi}{dy},\quad \alpha_3=\frac{d\xi}{dz};$$

$$\beta_1=\frac{d\eta}{dx},\quad \beta_2=\frac{d\eta}{dy},\quad \beta_3=\frac{d\eta}{dz};$$

$$\gamma_1=\frac{d\zeta}{dx},\quad \gamma_2=\frac{d\zeta}{dy},\quad \gamma_3=\frac{d\zeta}{dz};$$

this function will be, in the case supposed, homogeneous, and of the second order, and will contain forty-five constants, if no hypothesis be made as to the nature of the molecular action. Mr. Haughton deduces from it the general laws of *propagation* of waves, and the particular conditions at the limits, which give the laws of *reflexion and refraction.* If any particular form be given to this function, the laws of propagation, reflexion, and refraction will be completely determined; but Mr. Haughton shows that this is not the case in the inverse problem, which proceeds from the laws of propagation of waves to the form of the function. In this case, different forms of the function, *i. e.* different conditions of molecular action, may produce the same laws of propagation. No such indeterminateness attends the laws of reflexion and refraction, and while several forms of the function may give the same laws of propagation, there is but one unique form of function for the laws of reflexion and refraction; these laws, therefore, give (so to speak) a more intimate and profound knowledge of the molecular structure of bodies, than the laws of propagation. If, therefore, two mechanical theories give the same laws of propagation for a given body, it is impossible to determine which is the right theory, without having recourse to the laws of reflexion and refraction; these will afford the true *experimentum crucis* for such a case, which has actually occurred in the optical theories of Mr. Green and Professor Mac Cullagh, and is discussed by Mr. Haughton in the memoir.

Mr. Haughton deduces the following, among other results, for the *propagation* of plane waves.

1. That M. Cauchy's construction, for determining the direction of molecular vibration, holds true for the most general law of molecular action. There will be three possible directions of vibration for the same direction of wave plane, and the equations will contain thirty-six arbitrary constants, which

will be the coefficients of the six ellipsoids used by Mr. Haughton in his former paper.

2. If the body be incapable of transmitting *normal pressures*, and the vibrations be normal and transversal, and the normal vibration vanish, the general character of the medium will be restricted, and the function V will become a function of the quantities

$$\frac{d\eta}{dz}-\frac{d\zeta}{dy},\ \frac{d\zeta}{dx}-\frac{d\xi}{dz},\ \frac{d\xi}{dy}-\frac{d\eta}{dx}.$$

This is the function used by Professor Mac Cullagh, and denotes a body which can propagate exclusively transverse vibrations. The equation contains six constants.

3. If the body be incapable of transmitting *tangential pressures*, and be restricted to propagate exclusively normal vibrations, the function V will be reduced to a function of the quantity

$$\omega=\frac{d\xi}{dx}+\frac{d\eta}{dy}+\frac{d\zeta}{dz}.$$

The equations contain one constant.

These are the equations commonly used in hydrodynamics, and may be shown to signify the perpendicularity of pressure to a given plane; they are approximately true in the equations of the motion of air.

4. If the body be only restricted to propagate normal and transverse vibrations, the function V will consist of three parts; the first denoting exclusively normal vibrations; the second, exclusively transverse vibrations; and the third, vibrations of a peculiar character. It is to be remarked that, if the original function V were a function of the six quantities used by Mr. Haughton in his former paper, this third portion of the function would disappear.

All bodies may be placed between two limits, one limit being bodies capable of propagating exclusively normal vibrations, such as air, gases, &c., approximately; and the other limit being a body, such as the optical medium, capable of propagating exclusively transverse vibrations. Bodies lying between these limits are capable of propagating both normal and transverse vibrations, or, more generally, three definite directions of vibration, neither normal nor transverse. The consideration of the properties of bodies with respect to the propagation of plane waves supplies a valuable means of classifying them, and may lead to more important results.

The remainder of Mr. Haughton's paper is occupied with some particular applications of the general method, which are not suited to the limits of an abstract.

Sir William Betham read a paper on the proceedings of a commission issued by Cromwell in 1653 or 1654, to inquire into the circumstances and conduct of certain Scotch settlers who were transplanted from Ulster to Kilkenny and Tipperary.

Sir Charles Coote was Governor of Derry for the Parliament in 1648, and on the execution of the King, the Scottish settlers in Ulster became indignant, raised several regiments, and besieged Derry.

In 1653 a commission was issued to Sir Charles Coote, and five or six others, to inquire into the conduct of the Scottish settlers, and arrange for their transplantation from Ulster to Kilkenny and Tipperary. Sir W. Betham's paper is a copy of the Commissioners' Report, with the terms of the transplanting, and the names of the persons transplanted.

The collection of Ogham stones, referred to at p. 235, was presented to the Academy by the Rev. Charles Graves, on the part of Mr. Hitchcock, who communicated the following account of their discovery in different localities in the barony of Corkaguiny, County Kerry.

No. 1 is from the churchyard of Aglish. Another very imperfect one remains in this churchyard.

No. 2 was found in a bog at Ballineanig, about seven feet beneath the surface, and having about four feet of bog under it. In the same place were found part of a pot, which, by the description, appears to have been copper or brass, a portion of basket-work, and a quantity of burned wood, &c. A rude quern, appearing to have been in progress of dressing, was also found about seventy yards from where the preceding antiquities lay.

No. 3. Several pieces of an Ogham stone, found about three years since in an ancient rath at Brackloon. It is a source of regret that only portions of this apparently fine inscription should have been obtained, the greater part having been destroyed by some ignorant mason.

No. 4 was found at Martramane. It lay across a fireplace in a house now demolished.

Mr. Hitchcock presented two quern stones found in forts at Ballybowler and Doonmanagh, and a figured stone from the village of Kilvickadownig, all in the barony of Corkaguiny, county of Kerry.

He also presented a collection of skewer-like pieces of wood, called "arrows" by the peasantry, found in the bog on the top of the mountain of Coumanaire, barony of Corkaguiny, county of Kerry. They are found scattered about the broken and weather-beaten parts of the bog, for about a quarter of a mile all around. A few, which Mr. Hitchcock thinks remained sticking in their original place in the bog, were, respectively, two and a half and three feet below the present surface. Mr. Hitchcock collected 289 of these "arrows", of which he presented 264 to the Academy. There is a tradition current in the neighbourhood of a battle having been fought near the place where the arrows were discovered.

Mr. Yeates presented a Meteorological Journal for the year ending the 31st of January, 1848. (See Appendix, No. III.)

JANUARY 22ND, 1849.

REV. HUMPHREY LLOYD, D. D., PRESIDENT, in the Chair.

IT WAS RESOLVED,—On the recommendation of Council, that Mr. Eugene Curry be employed, at an expense not exceeding fifty pounds, to make a translation of the Irish Brehon law tract, which professes to give the laws of Cormac Mac Art, as compiled by Cennfaelad.

Mr. Donovan read the second part of his paper "On the deflections of the magnetic needle, &c."

In support of the eighteen laws read at the last meeting, the author adduced a series of experiments, which led to inferences very different from those on which reliance has been placed by the few who have investigated this subject. Of the various arguments and experiments brought forward, it would not be possible to give an abstract with any probability of rendering the subject intelligible.

Dr. Petrie gave an account of the stones presented by Mr. Bergin to the Academy.

Dr. Petrie observed, that he had remarked on his first visit to Connemara, about thirty years ago, that stones of this kind were very frequently preserved upon the altars, in the most ancient churches in that district and its adjacent islands. These stones were held in the highest veneration by the peasantry, as having belonged to the founders of the churches; and were used for a variety of superstitious purposes, as the curing of diseases, taking oaths upon them, &c. &c. Similar stones were preserved at Iona, and many other of the Hebrides, and had similar superstitions connected with them. He quoted several authorities on these facts, and some curious allusions to them in ancient Irish manuscripts.*

Dr. A. S. Hart read a paper on the form of geodesic lines through the umbilic of an ellipsoid.

If ω be the angle at the umbilic of an ellipsoid, between the principal section of the surface and any other geodesic line, and if θ be the angle between the plane of the principal section through the umbilics and the osculating plane of this geodesic line, at any point A, and if a be the semi-angle of the right cone circumscribing the ellipsoid at the point A, a, b, and c being the semi-axes of the ellipsoid, the angle θ may be determined by the following equation:

$$\frac{\tan\frac{1}{2}\theta}{\tan\frac{1}{2}\omega} = e^{\sqrt{(a^2-b^2)}\sqrt{(b^2-c^2)}\int_{\frac{\pi}{2}}^{\alpha}\frac{d\alpha}{\sqrt{(a^2\tan^2\alpha+b^2)}\sqrt{(c^2\tan^2\alpha+b^2)}}}.$$

Hence it follows that, as this line passes and repasses for ever through the two opposite umbilics, the tangents of the halves of the angles which it makes at these points with the plane of the umbilics will be a series of continued proportionals, the coefficient of the common ratio being determined by making $a = -\frac{\pi}{2}$ in the above equation.

If $c = 0$, the ellipsoid becomes a plane ellipse, and the geodesic line becomes the focal radius vector; and, the curvature being infinite at the circumference, it passes through the other focus, and so on for ever, forming, as before, a series of angles, such that the tangents of their halves are a series of proportionals.

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* Dr. Petrie's communication will appear in full in a subsequent number of the Proceedings.

February 12th, 1849.

REV. HUMPHREY LLOYD, D. D., President, in the Chair.

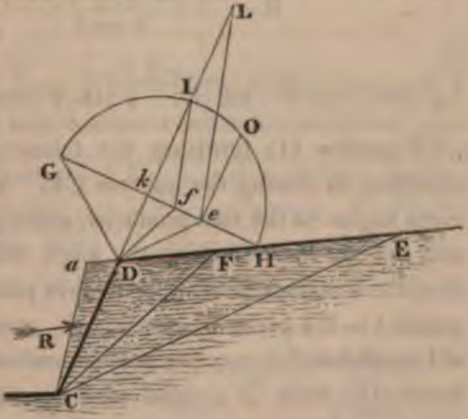
Maurice Colles, Esq.; Rev. John Magrath, LL. D.; Jeremiah J. Murphy, Esq.; and William Ogilby, Esq.; were elected Members of the Academy.

Mr. M. Donovan continued the reading of his paper on electricity.

Sir William Betham read a paper on the feudal land tenures and dignities, and their introduction into Ireland at the English conquest.

The Rev. Charles Graves, on the part of the Rev. Brice Bronwin, presented a paper on the theory of planetary disturbance.

Mr. J. Neville read a paper on the maximum amount of resistance acting in any direction required to sustain banks of earth or other materials, with sloping tops and faces, and the effects of friction between the face of the bank and the back of a retaining structure.



If CDE be any bank with a sloping face CD, and a sloping top, DE; CE the position of the

This value, however, is erroneous, and should be

$$R = \frac{h^2 w}{2} \times \frac{1}{\sin c' \sqrt{2} + 1 + \dfrac{\sin^3 c' \sqrt{2} + 3 \sin^2 c' + \sin c' \sqrt{2}}{\cos^2 c'}},$$

which, multiplied by sec c', to find the resulting resistance, is equal to the more simple form found above.

When $\theta = \beta$ the top slopes upwards at the angle of repose: in this case

$$\tan \phi = \tan \beta, \qquad (7)$$

$$R = \frac{wh^2}{2} \times \frac{\sin^2 \beta}{\sin (2c' + \beta)}. \qquad (8)$$

The second of these equations gives the greatest of the maximum values of the resistance: if the face be vertical, $\tan \beta = \frac{1}{\tan c'}$, and

$$R = \frac{wh^2}{2} \cos c'. \qquad (9)$$

The horizontal portion of this resistance is

$$R = \frac{wh^2}{2} \cos^2 c' = \frac{wh^2}{2} \sin^2 c. \qquad (10)$$

As this value is the same as (7[*]) the limiting value of the horizontal resistance, neglecting friction at the face, it appears that the limiting value of the horizontal resistance is the same whether friction at the face be taken in the calculation or neglected.

When the top slopes downwards at the natural slope,

$$\tan \phi = \tan \tfrac{1}{2}\beta, \qquad (11)$$

$$R = \frac{wh^2}{2} \, \frac{\sin \beta \tan \beta}{\cos 2c'} \left(\frac{\surd(\tan 2c' + \tan \beta}{\tan 2c' \sec \beta + \tan 2c' + \tan \beta} \right)^2. \qquad (12)$$

The value of the resistance here given is the least of the maximum values. If the face be vertical,

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[*] Proceedings, vol. iii. p. 86.

$$\tan \phi = \tan \tfrac{1}{2} c, \tag{13}$$

$$R = \frac{wh^2}{2} \sec c' \left(\frac{1}{2 \tan c' + \sec c'} \right)^2 . \tag{14}$$

The value of the angle of fracture is of the same form as that of Prony for a vertical face and horizontal top.

The equations show that the stability imparted to a structure at the face of a bank, by friction, arises principally from the direction of the resulting force, which makes an angle equal to the complement of the angle of repose with the face, and that this force is in general less than the horizontal force derived from the equation of Prony, or any other in which face friction is neglected ; that the values of both forces, for ordinary banks, are equal at angles of repose in and about 45°; that the former are least for angles of repose less than this, and the latter for angles of repose that are greater ; and that the direction of the resulting force makes it in no small degree a crushing force.

It also appears from the equations, that when the angle of repose is 45°, the face vertical, and top horizontal, that the tangent of the angle of fracture is ($\tfrac{1}{2}$) equal half the tangent of the angle of repose. The equation of Prony, for the same case, gives the tangent of the angle of fracture equal to the tangent of half the angle of repose.

In the following Table of Coefficients, for finding the maximum values of the resistances,

Column 1 contains the engineering names for the slopes corresponding to some of the angles of repose in Column 2.

Column 2 contains the angles of repose from which the coefficients of wh_1^2 are calculated.

Column 3 contains the complements of the angles of repose in column 2 ; or the angle which the direction of the *resulting resistance* makes with the face, taking friction thereof into account.

Column 4 contains the coefficients which, multiplied by

wh_1^2, give the value of the horizontal resistances when the top is horizontal and the face vertical; calculated from the "Equation of Prony."

Column 5 contains the coefficients which, multiplied by wh_1^2, give the values of the horizontal resistances, rejecting friction at the face, required to sustain banks with a horizontal top; the face sloping 10° from the vertical: $\theta = 80°$.

Column 6 contains the coefficients which, multiplied by wh_1^2, give the values of the *resulting resistances* when the top is horizontal and the face vertical, as in Column 4.

Column 7 contains the values of the coefficients, as before, for finding the *resulting resistances* when the top is horizontal and the face slopes 10° from the vertical, as in Column 5: $\theta = 80°$.

Column 8 contains the values of the coefficients for finding the values of the *resulting resistances* when the face overhangs 10° from the vertical, and the top is horizontal: in this case $\theta = 100°$.

Column 9 contains the resolved coefficients of wh_1^2 for finding the portions of the resistances in Column 6 at right angles to the face, which in this case are horizontal.

Column 10 contains the resolved coefficients of wh_1^2 for finding the portions of the resistances in Column 7 at right angles to the face. These, in this case, not differing much from the resolved horizontal portions, may be compared with those in Column 5.

Column 11 contains the resolved coefficients of wh_1^2, for finding the portions of the resistances in Column 8 at right angles to the face.

Column 12 contains the values of the coefficients which, multiplied by wh_1^2, give the ultimate or *maximum maximorum* values of the *resulting resistances;* the face being vertical and the top sloping upwards, at the slope of repose.

Column 13 contains the coefficients for finding the horizontal portions of the resistances determined from Column 12.

The length of the perpendicular from the toe of the face to the top, or top produced, is represented by h_1; and the length of the face itself by h.

wh_1^2 is multiplied by the coefficients in Columns 4 to 11 inclusive, to find the resistances; and wh^2 by the coefficients in Columns 11 and 12.

TABLE *of Coefficients for finding the maximum Values of the Resistances for different Angles of Repose; also the Coefficients for finding the ultimate Values of the Resistances when the Face is vertical, and Scarp at the natural Slope.*

1	2	3	4	5	6	7	8	9	10	11	12	13
3½ to 1*	16°	74°	.284	.228	.249	.218	.287	.239	.209	.276	.481	.462
	17	73	.274	218	.239	.207	.271	.228	.198	.259	.478	.457
3 to 1*	18½	71½	.259	.207	.226	.193	.266	.214	.183	.262	.474	.450
2½ to 1*	22	68	.228	.177	.197	.164	.210	.183	.152	.195	.464	.430
2 to 1*	27	63	.188	.141	.165	.130	.208	.147	.116	.185	.446	.397
	29	61	.173	.129	.155	.119	.197	.136	.104	.172	.437	.382
	31	59	.160	.117	.144	.108	.188	.123	.093	.161	.429	.367
	32	58	.153	.111	.139	.103	.183	.118	.087	.155	.424	.360
	33	57	.147	.106	.134	.098	.177	.113	.082	.149	.419	.352
1½ to 1*	34	56	.141	.101	.129	.094	.173	.107	.078	.143	.415	.344
	35	55	.135	.095	.126	.090	.169	.103	.074	.138	.410	.336
	36	54	.130	.090	.121	.086	.165	.098	.070	.133	.405	.327
	37	53	.124	.084	.117	.081	.161	.093	.065	.129	.400	.319
	39	51	.114	.077	.108	.074	.154	.084	.057	.120	.389	.302
	41	49	.104	.069	.102	.067	.146	.077	.051	.110	.327	.284
	43	47	.094	.062	.095	.061	.140	.069	.045	.102	.366	.267
1 to 1	45	45	.085	.054	.089	.055	.134	.063	.039	.095	.354	.250
	47	43	.077	.048	.083	.049	.129	.057	.033	.088	.341	.233
	49	41	.070	.042	.077	.044	.123	.051	.029	.081	.328	.215
	51	39	.062	.036	.072	.039	.118	.045	.025	.074	.315	.198
¾ to 1*	53	37	.056	.031	.066	.035	.113	.040	.021	.068	.301	.181
	55	35	.049	.027	.062	.031	.109	.036	.018	.062	.287	.165
	57	33	.048	.022	.057	.027	.105	.031	.015	.057	.272	.149

The slopes marked thus * are approximate.

In the preceding equations we have only considered the maximum *retaining-forces.* The minimum *overcoming-forces*, and the position of the corresponding fractures, are determined in a similar manner, and by similar equations. Retaining the same notation as before, we get, in this case, for the va of the *overcoming-force,*

$$R = \frac{why}{2} \times \frac{\sin(2c' + \beta - \phi)}{\sin(\delta - 2c' + \phi)}.$$

Where y is equal the perpendicular from (F) on the face, face produced.

If we put

$$\beta_1 = 2c' + \beta,$$

and

$$\delta_1 = \delta - 2c';$$

the above equation, after a few reductions, becomes

$$R = \frac{why}{2} \times \frac{\cos\beta_1}{\cos\delta_1} \times \frac{\tan\beta_1 - \tan\phi}{\tan\delta_1 + \tan\phi}.$$

When this is a minimum,

$$\tan\phi = \frac{\tan\beta_1\sqrt{(\tan\theta\tan\delta_1)}}{\sqrt{(\tan\theta\tan\delta_1)} - \sqrt{\{(\tan\theta - \tan\beta_1)\times(\tan\beta_1 + \tan\delta_1)\}}}$$

$$R = \frac{wh^2\tan\theta\sin\beta_1\tan\beta_1}{2\cos\delta_1}.$$

$$\left(\frac{1}{\sqrt{\{\tan\theta(\tan\beta_1 + \tan\delta_1)\}} - \sqrt{\{\tan\delta_1(\tan\theta - \tan\beta_1)\}}}\right)^2;$$

in which the usual changes of signs are to be made for negative values of δ_1, and for arcs greater than 90°.

When the direction of the force makes an angle equal with the face, then $\delta_1 = 0$, and,

$$\phi = 0,$$

$$R = \frac{wh^2}{2}\sin\beta_1.$$

If the force exceed the value of R here found, it will slide al the face, and when the face is vertical this value is equa the *maximum maximorum* value of the resistance, in the s case, already found; or,

$$R = \frac{wh^2}{2} \sin c.$$

When $\theta = 90°$, the general equations become

$$\tan \phi = \frac{\tan \beta_1 \sqrt{(\tan \delta_1)}}{\sqrt{(\tan \delta_1)} - \sqrt{\{(\tan \beta_1 + \tan \delta_{11})\}}}, \tag{20}$$

$$R = \frac{wh^2 \sin \beta_1 \tan \beta_1}{2 \cos \delta_1} \left(\frac{1}{\sqrt{(\tan \beta_1 + \tan \delta_1)} - \sqrt{(\tan \delta_1)}}\right)^2. \tag{21}$$

If the force in this case be supposed to act horizontally $(\delta_1 + \beta_1 = 90°)$, these equations may be reduced to

$$\tan \phi = \cot \left(c - \frac{\beta}{2}\right); \tag{22}$$

$$R = \frac{wh^2}{2} \cot^2 \left(c - \frac{\beta}{2}\right). \tag{23}$$

If the face be vertical, then $\beta = c$, and the equations may be further reduced to

$$\tan \phi = \cot \tfrac{1}{2}c; \tag{24}$$

$$R = \frac{wh^3}{2} \cot^2 \tfrac{1}{2}c. \tag{25}$$

The Rev. Charles Graves communicated the following note respecting geodetic lines on surfaces of the second order.

"At a meeting of the Academy which took place in last June, I stated a general theorem, from which I am able to deduce Joachimsthal's theorem respecting the geodetic lines traced on a central surface of the second order; and at the same time to show geometrically the reason why the property enunciated in it is common to geodetic lines and to lines of curvature. From the general theorem to which I refer, the following proposition is a corollary:

"*If a central surface of the second order* (A) *be circumscribed by a cone* (a), *the quantity* PD *is the same for* L, L′, L″, L‴, *four sides of the cone which make equal angles with its internal axis:* P *denoting the perpendicular from the centre* *of the surface on the tangent plane passing through one of thos sides, and* D *the semidiameter parallel to that side.*

"If V, the vertex of the cone, be supposed to approach indefinitely near to a point on the surface, its axes ultimately coincide with the normal at that point, and the tangents to the lines of greatest and least curvature passing through it. The plane of two successive elements of a geodetic line through V contains the normal, and those elements are equally inclined to it. So likewise the plane of two successive elements of a line of curvature passing through V contains the tangent to that line of curvature at V; and the elements themselves are equally inclined to the normal. In virtue of the preceding proposition we are, therefore, entitled to conclude, that the quantity PD remains unaltered for two successive elements, either of a geodetic line or of a line of curvature traced on a central surface of the second order.

"Returning to the case in which the vertex of the cone is at a finite distance from the surface, we may now say that

"*If a central surface of the second order* (A) *be circumscribed by a cone* (a), *the quantity* PD *is the same for the geodetic lines which are the prolongations of* L, L′, L″, L‴, *four sides of the cone which make equal angles with its internal axis.*

"In what follows I shall suppose the surface (A) to be an ellipsoid, in order to avoid the enumeration of a variety of cases. The conclusions arrived at may, however, be adapted to the hyperboloids by obvious modifications.

"The four sides of the cone, denoted according to their order by L, L', L'', L''', being all tangents to geodetics on the ellipsoid for which PD is the same,* are likewise all tangents to the same confocal hyperboloid (B), which intersects the surface (A) in the pair of opposite lines of curvature touched by the geodetics. The cone (b), therefore, which envelopes (B), and has the same vertex as (a), is confocal with (a), and intersects it orthogonally. The normal planes to (a) along L and L'', being thus tangent planes to (b), intersect in a right line drawn from V to the pole of the plane LL'' with relation to (B). Moreover, this right line lies in a plane perpendicular to the internal axis of the cone (a), and therefore makes equal angles with L and L''.

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* I think it would be convenient, in future, to designate geodetic lines of this kind as *similar* geodetics.

"Suppose now that the straight lines L and L'' be replaced by a continuous flexible and inextensible cord, which is kept stretched by a style at V, and prolonged in the direction of geodetic lines to two fixed points p, p'', at which it is attached to the surface: it is easy to show that the style will trace a curve on an ellipsoid (A') passing through V, and confocal with (A); whilst it moves in such a manner as to allow the cord to roll on one, and off the other, geodetic line. In fact the path described by the style at the beginning of its motion, if any motion be possible under the prescribed conditions, must be in the intersection of the two planes through L and L'', which are normal to (a): and we have already seen that this intersection is in a plane perpendicular to the internal axis of the cone (a), that is, in the tangent plane to a confocal ellipsoid passing through V. But further, motion is possible, though the length of the cord remains unaltered; since the two straight parts of it are equally inclined to the line of intersection of the two normal planes. From what has been said above we may derive a simple mode of determining the direction of the tangent to the curve traced on (A') at the point V. For this purpose we must draw a right line from V through the pole of the plane of the two straight portions of the cord, taken with relation to the hyperboloid (B).

"What has been already proved with respect to L and L'' holds good in like manner for L' and L'''. And it is to be observed that the paths described by the style on (A'), corresponding respectively to these two pairs of opposite sides, though not the same, are equally inclined to the lines of curvature on (A') passing through V. This suggests the theorem, that if the plane of L and L'' be a principal plane of the cone, the path of the style will touch a line of curvature on (A) at V.

“ Let us next consider a pair of adjacent sides of the cone, such as L and L'. Normal planes to the cone (a) along these sides intersect in a right line, which lies in a plane perpendicular to that external axis of the cone (a), through which the plane of L and L' passes. Hence it follows, as before, that two intersecting cords, L and L', may be both rolled on, or both rolled off the geodetic lines upon which we suppose them prolonged to fixed points, p and p', in such a manner that the shortest distances between their intersection and the fixed points p, p', shall have a constant *difference*. And their intersection at V will lie upon a hyperboloid (B'), confocal with the ellipsoids (A) and (A').

“ Lastly, considering the pair of sides L and L''', and cords produced along them to fixed points p, p''', .on the geodetic lines touched by them, we see that if the difference between the lengths Vp, Vp''' remain constant, V will trace a curve on a second hyperboloid (C''), which passes through V, and is confocal with (A') and (B').

“ It is obvious that the curve described by the point V, under the circumstances considered above, is not, in general, a geodetic line on a surface confocal to (A). We may, however, regulate the motion of the cords so as to effect this.

“ For instance, let the four cords, L, L', L'', L''', be prolonged in the direction of similar geodetics until they touch two opposite lines of curvature, along which they are thenceforth applied and carried on to fixed points, p, p', p'', p'''. Then a style at V, stretching a continuous cord pVp'', which coincides with two *opposite* sides of the cone, L and L'', will trace *a geodetic line* upon the confocal ellipsoid (A'), provided it be made to move always in the plane of the two straight portions of the cord; whilst the parts which coincide with geodetic lines on (A) roll, one of them on, and the other off, its corresponding line of curvature.

"If, on the other hand, we consider a continuous cord pVp' coincident with a pair of *adjacent* sides of the cone, as L and L', we see that the locus of the style at V, which keeps it stretched, will be *a line of curvature* on a confocal ellipsoid, if the conditions of motion be the same as before.

"The theorems here announced are meant to take the place of two which were incorrectly given at page 192. I fell into an error in the statement of them, partly by my haste in generalizing from particular cases in which they are true; and partly in consequence of my having formed an inaccurate conception of the *form* of geodetic lines in general.

"For clearer views as regards this latter point, I acknowledge myself indebted to the recently published researches of my friend, Dr. Hart.

"I may be allowed to take the present opportunity of mentioning, that a theorem lately announced by him to the Academy, respecting the form of a geodetic line which passes through an umbilic, may be derived geometrically from a theorem discovered by Mr. Michael Roberts.

"Mr. Roberts has shown that if two geodetic lines be drawn from the interior umbilics of a line of curvature of an ellipsoid to the same point on the curve, the product of the tangents of the halves of the angles which they make with the arc of the principal ellipse joining the umbilics is constant.

"Suppose now that the line of curvature referred to in the preceding proposition is a principal section passing through the extremities of the mean axis. Let U and U_1 be its interior umbilics, and U', U_1' the umbilics diametrically opposite. Geodetic lines drawn from U and U_1 to a point S, taken anywhere in this principal section, make with the arc UU_1 angles SUU_1, SU_1U, the product of the tangents of whose halves is constant. Prolong either of these geodetics

US to the opposite umbilic U'. Then, by reason of the symmetry of the surface, we shall have the angle $SU'U$ equal to SU_1U', and supplemental to SU_1U. Consequently the tangents of the halves of SUU_1 and $SU'U_1$ are to each other in a constant ratio. From this it appears that the principal ellipse passing through the umbilics is a common asymptot to all the geodetic lines which pass through either umbilic.

"Though the umbilical geodetics are thus shown to be infinite spires, it is not true that all the geodetics on the surface of an ellipsoid are of the same nature. Besides the geodetics which coincide with the principal sections of the surface, there are others among them which are closed curves. An example will make this evident.

"A circular disc, with a regular figure of an even number of sides inscribed in it, may be regarded as an infinitely flattened spheroid of revolution, with a continuous geodetic line traced upon its surface. In fact a closed cord, carried along in the direction of the sides of the regular figure, and passing over at each angle to the opposite side of the disc, would be kept stretched round it.

"I hope to be able, before long, to communicate to the Academy a series of remarkable results respecting the comparison of similar geodetic arcs, at which I have arrived by means of the theorems stated in the beginning of the present note. I expect also, by the translation of these geometrical theorems into analytical language, to obtain some new relations between the integrals, to the consideration of which we are led in the rectification of the geodetic lines and lines of curvature of a surface of the second order."

Rev. William Roberts communicated an analytic proof of the theorem stated by Mr. Graves, and made some observations on different applications of the formula of M. Liouville, on which the proof depends.

"The theorem which Mr. Graves has announced results in a very simple manner from a formula given for the first time, I believe, by Mr. Haedekampe, of Hamm, in the twenty-fifth volume of Crelle's Journal, page 180. In a memoir published in the twelfth volume of the *Journal de Mathematiques*, M. Liouville has demonstrated the same formula from geometrical considerations, and has attached a very elegant and precise signification to it. As the theorem in question, regarded under this point of view, is the natural extension to the case of three dimensions of the property (discovered by Mr. Graves), relating to the excess of the sum of the tangents drawn to an ellipse from a point upon a confocal ellipse over the included arc, it will be well to show how this latter proposition may be established by the method to which I allude. The generalization will be seen to follow without any difficulty.

"Let us adopt the notation of elliptic co-ordinates. The differential of the length of a right line tangent to an ellipse defined by the equation $\mu = a$, will be

$$d\mu\sqrt{\left(\frac{\mu^2 - a^2}{\mu^2 - b^2}\right)} + d\nu\sqrt{\left(\frac{a^2 - \nu^2}{b^2 - \nu^2}\right)},$$

where $2b$ is the constant distance between the foci. Now, if we remember that the second term is precisely the differential of an arc of this ellipse, and if we fix the origin of the ν's at a point (P) on the ellipse, it is clear that the above expression will be equally the differential of the mixtilineal line, composed of an elliptic arc, one of whose extremities (P) is fixed, and of the right line tangent on the other extremity. Let us now consider a pair of tangents drawn from a point O to an ellipse, and let T, T' be the points of contact, and P, Q two fixed points on the ellipse. Then the differential of the mixtilineal line $OT + TP$ will be

$$\sqrt{\left(\frac{\mu^2 - a^2}{\mu^2 - b^2}\right)} + d\nu\sqrt{\left(\frac{a^2 - \nu^2}{b^2 - \nu^2}\right)},$$

and that of the mixtilineal line $OT' + T'Q$ will be

$$d\mu\sqrt{\left(\frac{\mu^2-a^2}{\mu^2-b^2}\right)}-d\nu\sqrt{\left(\frac{a^2-\nu^2}{b^2-\nu^2}\right)}.$$

Hence, $OT + OT' + (TP + T'Q)$ will be constant, if $d\mu = 0$, that is to say, if O describe an ellipse confocal with the given one.

" We may now pass to the consideration of the analogous theorem for the dimensions. The differential of a right line, common tangent to two confocal surfaces of the second degree, is in elliptic co-ordinates ρ, μ, ν,

$$d\rho\sqrt{\left\{\frac{(\rho^2-\alpha^2)(\rho^2-\beta^2)}{(\rho^2-b^2)(\rho^2-c^2)}\right\}}\pm d\mu\sqrt{\left\{\frac{(\alpha^2-\mu^2)(\mu^2-\beta^2)}{(\mu^2-b^2)(c^2-\mu^2)}\right\}}$$
$$\pm d\nu\sqrt{\left\{\frac{(\alpha^2-\nu^2)(\beta^2-\nu^2)}{(b^2-\nu^2)(c^2-\nu^2)}\right\}} \qquad (a)$$

b, c being the well-known constants in this system of co-ordinates, and α, β, the parameters which determine the two surfaces above mentioned. Let one of them be defined by the equation $\rho = \alpha$, and the sum of the second and third terms, in the foregoing expression, will be the differential of a geodesic line traced upon this surface. Hence, the expression (a) may be regarded as the differential of the mixtilineal line, composed of a geodesic line (G) upon the surface $\rho = \alpha$, counted from a fixed point, and of the linear tangent to it at its variable extremity. And if we consider the geodesic line (G') upon the same surface for which the coefficients of $d\mu$ and $d\nu$ are of opposite signs from those in the case of the line (G), we may easily see that if the sum of two arcs of the lines G and G', counted from fixed points, together with the lengths of the tangents applied to them at their variable extremities (which obviously intersect), be constant, the locus of their intersection will lie in a surface having for equation $d\rho = 0$, that is to say, a surface confocal with the given one. The same expression (a) leads, with equal facility, to a theorem of M. Chăsles respecting lines of curvature. In order to obtain this theorem it will be necessary to consider one term in the formula, which will be the differential of an arc of a line of curvature; just as, by considering two conjointly, we were led to the expression for the length of a geodesic arc.

"The formula of M. Liouville, which I have employed, admits of being interpreted in several ways. For instance, analytically speaking, it gives us Abel's theorem respecting the comparison of ultra-elliptic functions of the first class and second species; and, regarded under this point of view, it furnishes us with the solution of the following problem:

"'Being given three arcs of a line of curvature on a surface of the second degree, to determine two others dependent upon them algebraically, so that the sum of the five arcs, taken with their proper signs, may be equal to a right line.'

"In conclusion, I beg to disclaim any originality in the foregoing communication. Everything which I have advanced on the subject is implicitly contained in the very elaborate memoir of my friend M. Liouville."

February 26th, 1849.

REV. HUMPHREY LLOYD, D. D., President, in the Chair.

On the recommendation of the Council,

It was resolved,—That £100 be placed at the disposal of the Secretary of the Academy, for the purchase of Irish MSS. at the Stowe sale.

The President communicated some facts respecting the remarkable atmospheric wave which passed over Dublin in the course of the present month, together with a notice of the more considerable barometric oscillations observed at Dublin since the beginning of the present century.

The greater barometric oscillations at a given place may be considered as the effects of the passage of large atmospheric waves, the direction and velocity of which can be traced by simultaneous observations made at distant stations. This view, originally propounded by Sir John Herschel, has been confirmed by Mr. Birt, who has traced with much care and skill the progress of some very remarkable waves over Europe. Much, however, yet remains to be done in connexion with this subject. It is still to be ascertained to which of the two great classes of waves (waves of *translation*, or waves of *oscillation*), the great aerial waves are to be referred; and it is far from certain, that the dynamical relation between the molecular movement and the phase of the oscillation, which holds in the known forms of waves, will explain the phenomena of the dependence of the wind upon the barometric pressure.

The chief difficulty in the way of the solution of these questions arises from the fact, that the aerial disturbance is in general the compound effect of the passage of several waves, moving in different directions, and that the phenomena are thus interwoven and complicated. It is, therefore, important, with a view to the disentanglement of their laws, that the cases at first selected for examination should be, as far as possible, free from this complexity. In this point of view, the greater barometric oscillations, in which the principal movement generally predominates over the subordinate, are especially deserving of attention; and on this account, as well as its very unusual nature, the wave of the present month seems to call for the especial consideration of meteorologists. Its complete discussion will, of course, demand the comparison of observations at several stations; meanwhile the following facts respecting it, as observed at Dublin, are given as a contribution to the history of its progress.

The barometer began to rise at Dublin on the 28th of January, and reached a small maximum on the following day. This was followed by a slight depression on the forenoon of the 30th, after which the transit of the first portion of the wave commenced,—the barometer continuing to rise (with a slight interruption) from this epoch, and reaching its maximum on the morning of February 5. The mercury then descended until the morning of February 8, when the trough dividing the two portions of the wave passed. It then began to ascend, although not continuously; and on the 10th the ascent became very rapid, the mercury rising 0·6 inch between 10 A. M. on the 10th and 10 A. M. on the 11th, when it attained the extraordinary height of 30·904 inches. The crest of the wave passed at about 11 A. M. The descent of the mercury was more gradual; it reached a relative minimum on the morning of the 13th, from which period, until the passing away of the wave, there were three minor oscillations. The posterior slope of the wave passed February 18; and after a small but abrupt rise on the afternoon of the following day, the mercury fell to 29·628 on the 20th.

The following Table, taken from the registry of the Magnetical Observatory, gives the heights of the barometer at 10 A. M. and 10 P. M. during the passage of the wave. It was accompanied by a diagram.

Observations of the Barometer during the passage of the Atmospheric Wave, in February, 1849.

Date.	10 A.M.	10 P.M.	Date.	10 A.M.	10 P.M.	Date.	10 A.M.	10 P.M.
Jan. 28	29·434	——	Feb. 5	30·468	30.435	Feb. 13	30·560	30·725
29	30·087	30·058	6	·389	·330	14	·673	·556
30	29·817	·041	7	·274	·083	15	·636	·622
31	30·256	·310	8	·042	·285	16	·52	·528
Feb. 1	·180	·215	9	·353	·170	17	·64^{1}	·473
2	·279	·284	10	·301	·656	18	·45^{4}	——
3	·314	·331	11	·904	·848	19	29·87^{2}	·058
4	·431	——	12	·672	·517	20	·71^{6}	

It is a circumstance deserving of notice, that the direction of the wind continued nearly unchanged during the whole period of the transit. The wind was from between W. and SW. at the commencement, and continued between the same points (with a very brief interruption on Feb. 1) until the passage of the crest of the wave, when it shifted temporarily to the NW. (Feb. 11, 12); it then returned to W. and SW., and so continued during the remainder of the passage. There was a high gale before the commencement of the transit (Jan. 22–26); and another (Feb. 19, 21, 22) after its completion. The wind was also high, February 7–10, reaching its maximum February 9, shortly after the passage of the trough dividing the two portions of the wave. During the passage of the crest it was calm.

The barometer never attained so great a height since the regular series of meteorological observations commenced (ten years ago) at the Magnetical Observatory. In order to ascertain whether so great a pressure had been observed at an earlier period, Dr. Lloyd consulted the long and regular series of observations kept by the late Dr. Orpen, and presented by him to the Academy. It appeared from this examination that, within the last forty-five years, the barometer only once attained an equal height. This took place in January, 1825. It may not be uninteresting to meteorologists, with a view to the questions above referred to, to possess a record of the epochs of the occurrence of the greater barometric oscillations, as observed at Dublin. Accordingly the following Table has been prepared, giving the list of days from 1805 to 1848, inclusive, on which the mean daily height of the barometer exceeded 30·50 inches, together with the observed maxima. The observations from 1805 to 1838, inclusive (taken from Dr. Orpen's register), are uncorrected.

List of Days on which the mean Height of the Barometer exceeded 30·50 *Inches, with the observed Maxima.*

Date.	Max.
1805. Sept. 28–30,	30·60
Nov. 13–16,	·70
1807. Jan. 1,	·50
Feb. 28–Mar. 1,	·60
1808. Feb. 24–26,	·70
1816. Nov. 30,	·52
1817. Nov. 19,	·58
1818. Apr. 2, 3,	·53
Dec. 28–Jan. 1,	·75
1820. Jan. 9,	·67
1821. Jan. 22, 23,	·57
1822. Feb. 27,	·52
1824. Jan. 15–17,	·66
May 26, 27,	·60
1825. Jan. 5–12,	·93
Mar. 20, 21,	·60
1826. Nov. 20, 21,	·58
Dec. 27, 28,	·56
1827. Feb. 3–8,	·65
Aug. 23,	·51
Dec. 28,	·65
1829. May 25, 26,	·58
Dec. 31–Jan. 3,	·67
1830. Mar. 26, 27,	·53
Oct. 5,	·50
1831. Jan. 7,	·57
Mar. 31–Apr. 1,	·63
Dec. 27, 28,	·54
1832. Feb. 10,	·59
Apr. 4,	·50
May 10,	·56
Sept. 20, 21,	·58
Nov. 6,	·52
1833. Jan. 3–8,	·64
Jan. 23,	·52
July 30,	·55
1834. Mar. 14–18,	·60
Apr. 3, 4,	·58
May 21–24,	·57
Oct. 26–29,	·64
Nov. 14–16,	·64
1834. Dec. 10–26,	30·74
1835. Jan. 2–6,	·80
Mar. 24–26,	·80
Apr. 22, 23,	·58
Dec. 22, 23,	.62
1836. Jan. 2,	·58
May 14–17,	·64
Dec. 31–Jan. 2,	·70
1837. Jan. 15,	·54
Apr. 8,	·58
Oct. 12–15,	·70
Oct. 20, 21,	·60
1838. Mar. 28, 29,	·60
Oct. 2, 3,	·60
Dec. 8,	·54
1839. Jan. 23, 24,	·692
Apr. 9–11,	·690
Oct. 28,	·542
1840. Feb. 26,	·598
Mar. 2–10,	·751
Mar. 20, 21,	·654
Oct. 12, 13,	·598
Dec. 3,	·594
1841. Jan. 21,	·562
Feb. 24, 25,	·642
1842. Jan. 7,	·563
1843. Sept. 23,	·614
1845. Apr. 16,	·535
Oct. 22,	·553
Dec. 12,	·552
1846. Jan. 9,	·567
Feb. 10,	·514
Mar. 11, 12,	·615
Sept. 12, 13,	·521
Dec. 30, 31,	·585
1847. Mar. 1–4,	·692
May 31–June 2,	·559
Nov. 17,	·585
1848. Jan. 11–13,	·650
Jan. 24,	·600
Nov. 9–15,	·667

It appears from an examination of this list that the period of maximum frequency of unusually high pressures is in January, and that of the minimum in July. This is precisely what might have been expected, the former period being that of the maximum range of the irregular oscillations, and the latter that of the minimum.

Of the barometric oscillations contained in this list there are some which deserve particular notice.

The oscillation of January, 1825, is (as has been already remarked) the most considerable; and its features resemble, in many respects, those of the wave of the present month. The barometer began to rise Dec. 27, after which the mercury executed a series of rapid oscillatory movements. On Jan. 4 it began to rise continuously, and attained the height of 30·93 on the morning of Jan. 9. The subsequent descent was gradual and regular. The entire wave occupied a period of twenty-two days in its passage. During the minor oscillations at its commencement, the wind was exceedingly variable; it settled in the NW., (January 1–4). From the 4th to the 6th, during the passage of a minor oscillation, it shifted from NW. through E. to SE.; and the movement continued in the same direction from the 6th to the 9th, during the passage of the anterior slope of the great wave, when it completed an entire gyration. From the 9th to the 11th the wind continued in the NW., and then retrograded through a quadrant to SW. during the passage of the posterior slope. It was high at the commencement and end, and calm during the passage of the crest, as in the wave of the present month.

The oscillation of March, 1840, is the next in magnitude, as respects the height attained; but is much the most considerable of any recorded in the duration of the oscillation, which embraced a period of forty-five days (February 15–April 1). Owing to this continuance of high pressure, the mean pressure for the month of March, 1840, amounted to 30·383, the highest monthly mean of which the writer was aware. This wave was composed of seven oscillations, three at each side of the central one; and the barometric curve presented a very symmetrical character. It culminated on March 9th, when at 9 A. M. the barometer attained the height of 30·751 inches. The wind was easterly during the whole transit, but varied very irregularly between SE. and NE.

The barometric curve of March, 1847, is remarkable for its regularity, and its near approach to symmetry. The wave commenced its passage over Dublin Feb. 18, culminated March 2, and passed off March 15, its transit occupying twenty-five days. The highest pressure (March 2, 7 P. M.) was 30·692 inches. The central portion of the curve presenting a great regularity of form, and predominating greatly over the minor oscillations, this wave seems admirably suited to the examination of the relation between the molecular movement of the air and the pressure. The principal features of the phenomenon were a steady wind from SE. (Feb. 22–26), preceding the rise of the principal oscillation. This was followed (Feb. 28–March 6) by a steady wind from NE. during its transit, and (March 7–8) by a NW. wind after its passage. The oscillation is also remarkable for a retrograde movement of the wind through nearly the whole compass. The wave commenced and ended with a gale; the intensity of the wind increased also before and after the principal oscillation.

The writer concluded by some remarks upon the bearing of the facts noticed upon the theory of wave-propagation.

The following notice on the manufacture of sulphuric acid, by Professor Edmund Davy, was communicated by Professor Graves.

"My attention has been for some time directed to the consideration and examination of the different circumstances under which sulphuric acid may be formed; as by the use of the nitrates of potash or soda, and nitric acid or nitrous acid gas, with sulphur. I have also particularly directed my attention to the agency of atmospheric air on burning sulphur, and a number of the sulphurets; and the action of oxygen gas on sulphur under different circumstances. The time I have devoted to these inquiries, though considerable, has not been sufficient to complete them: but as I can only pursue the subject at short intervals of leisure, I trust I shall be excused for bringing before the Academy results, which, though imperfect, appear to me to be both novel and important.

"Sulphuric acid, from its vast importance to our arts and manufactures, has, from time to time (as is well known), engaged much scientific attention. Some of the most distinguished chemists of Europe have made it the subject of elaborate inquiry and investigation; yet it is a remarkable fact, that they appear to me to have overlooked the manner in which it is formed under different circumstances; and their authority, it is to be feared, checked inquiry, and tended to confirm and perpetuate error. It is a received opinion that sulphuric acid cannot be made directly from its elements, sulphur and oxygen, but is produced by causing sulphurous acid to unite with an additional equivalent of oxygen in contact with moisture or water. That opinion, however, is the result of imperfect observation, and is not founded in fact. Sulphuric acid may be made with facility from its elements, under different circumstances. Thus, if we burn sulphur in atmospheric air at the lowest possible temperature, in contact with glass, porcelain, metals, &c., the products will be sulphurous and sulphuric acids. If we burn sulphur in air at higher temperatures, in contact with the same substances, the results will be similar, but the quantity of sulphuric acid produced will be greater than would be formed at lower degrees of heat.

"Sulphurous acid is considered to be the sole product arising from the combustion of sulphur in dry oxygen gas, or atmospheric air. I am satisfied this is not the fact. I have repeatedly burned sulphur in oxygen gas under different circumstances, and I have uniformly obtained sulphurous and sulphuric acids. I will not refer to any particular experiments in which these acids were produced directly from oxygen gas and sulphur in a dry state, as I am desirous of repeating them at my first leisure, under more favourable circumstances.

"I have repeatedly found that by burning the vapour of sulphur in flasks and retorts, under circumstances in which it would be difficult to admit the presence of any appreciable quantity of water, sulphuric acid as well as sulphurous acid is copiously produced.

"In the well-known method of making sulphurous acid gas, by heating a mixture of sulphur and oxide of manganese, it is supposed no sulphuric acid is formed. This is a mistake. Sulphate of manganese is produced, together with a rich brown pigment, probably the sesquioxide. This sulphate is employed in dyeing and calico printing, and is now prepared by more complicated processes. In experiments with the Saxon and other varieties of manganese and sulphur, I have obtained pure sulphates of manganese. And this method seems to offer the chemist one of the readiest modes of obtaining the compounds of manganese in a state of purity, and of detecting it in analyses.

"The application of the foregoing facts to the manufacture of sulphuric acid seems obvious, but I hope in a subsequent communication to bring that subject before the Academy.

"I cannot close this communication without acknowledging the assistance I received in my experiments from my intelligent young friend and pupil, Mr. George Keogh, and my son, Edmund William Davy."

Mr. Robert Mallet made the following observations on Mr. Davy's paper:

Mr. Robert Mallet stated that about sixteen years since gentleman named Talbot called on him, and mentioned the fac that sulphur burned in air produced both sulphuric and sulphurous acids, which he proposed to take advantage of in new mode of manufacturing the sulphuric acid of commerce

In conjunction with this gentleman, Mr. Mallet expended a good deal of money in experiments as to the feasibility of the proposed method. The apparatus, briefly, consisted in chamber in which sulphur could be burned at as high a temperature as was consistent with the non-volatilization of much of it; this communicated with the usual lead vitriol chamber by a large tube, dipping a little under the surface of the water therein. By means of a powerful air-pump, or fan, a partial vacuum was now produced in the vitriol chamber, which caused a draught through the chamber in which the sulphur was burned, the gases from which, bubbling up through the water in the vitriol chamber, were in part condensed in the water.

Abundance of a sour liquor was obtained; but it was found that, under the best possible conditions, the amount of sulphuric acid formed was so very small in proportion to that of the vast volume of sulphurous acid generated, and which was all wasted, that the process was valueless.

The higher the temperature at which the sulphur was burned, the greater was the proportion of sulphuric acid formed; but the limit to this was found to be such a draught through the apparatus as would blow out the feeble flame of the burning sulphur; and at this point the per centage of sulphuric acid was so small that Mr. R. Mallet had satisfied himself the process could not be advantageously adopted. The communication of Professor Davy was valuable, as placing upon record (he believed for the first time) a fact theoretically passed over or misstated in chemical authors, but was not likely to lead to a manufacturing improvement.

Dr. Croker King made the following communication on the adjustment of the chordæ vocales by the oblique arytenoid muscles:

"In the course of the following communication, it will appear that a peculiar position of the vocal cords is necessary for the production of a distinct intonation; and that, if the vocal cords be not brought into this favourable position, the larynx will cease to execute its function as an organ of voice.

"The means by which this essential adjustment is effected has been a matter of uncertainty and doubt; and the object of this communication is to show that there exists in the human larynx an apparatus of great efficiency, which is capable of executing the desired movement with accuracy and precision; and that, although the muscular fibres which perform this office have been well known to anatomists and physiologists, this special use has not hitherto been assigned to them.

"The term *larynx* has been applied by anatomists to a cylindrical box, which surmounts the trachea or windpipe, and contains the organ of voice. The box is formed of a resisting material, so that its capacity may not be diminished or obliterated by the collapse or falling in of the sides, which, were its parietes formed of a flaccid material, would inevitably result from an effort of inspiration. The animal structure used is named cartilage, and there are several distinct pieces of this material in the larynx; they are connected to each other so as to form articulations or joints, and, appropriate muscles being assigned to them, they can be freely moved upon each other.

"It is not my intention to occupy the time of the Academy by entering into a detailed description either of the laryngeal cartilages or muscles, but to confine myself to such notice of the anatomical features of the larynx as is absolutely required to render the particular object of this communication intelligible.

"The trachea or windpipe is surrounded by a strong ring of cartilage termed the cricoid, which serves as a foundation upon which the superjacent mechanism is erected. Upon the upper and posterior margin of this cartilage are seated two small solid triangular bodies, named the arytenoid cartilages, and the entire is embraced and protected in front and on the sides by a large shield-shaped cartilage, the thyroid; in this manner the skeleton of the larynx is constructed.

"The base of each arytenoid is concave and of a triangular figure, with two of the angles (the anterior and external) so prolonged as to represent two little processes, which we shall designate spurs; the external spur receives the insertion of two muscles, and from the anterior spur of each cartilage there passes forwards a remarkable cord, which attaches itself in front to the thyroid cartilage. The cords are highly elastic, and it is the varied tension and vibrations of these, the vocal cords, which produce the several intonations that admit subsequently of being fashioned into those articulate sounds of which language is formed.

"The interval between the vocal cords and the inner margins of the base of the arytenoid cartilages is named the rima or chink of the glottis, which in a state of repose (none of the laryngeal muscles being in action) is of the form of the head of an ancient halbert; and *mark*, while in this position, the surfaces of the cords are inclined *from* each other, and the cords are in a state of relaxation. A column of air, though even propelled with force through the rima, under these circumstances, does not produce any distinct sound. For the production of an intonation, two conditions are required, namely, that a certain amount of tension be communicated to the vocal cords, and, above all, that the surfaces of the vibrating material be inclined towards each other, or, at all events, that their planes should become parallel to the axis of the column of air ascending through the tube; for the slightest inclination of the surfaces from this axis completely prevents any sonorous vibration from being produced. In order to illustrate this fact I have arranged a rough experiment. Here are two tubes closed at one extremity, with the exception of a narrow slit; projecting beyond this extremity of each of the tubes are two pieces of wood, so fashioned that when this piece of elastic membrane is stretched across the extremity of one tube, the surfaces of the membrane will diverge slightly, while, if the same membrane be extended across the other, the surfaces will be parallel, or a little convergent. A column of air, as you may perceive, propelled through the former tube, will only produce a rustling noise, but in the case of the latter a distinct intonation will result.

"It has been already stated that the manner in which this adjustment of the vocal cords, so necessary for the production of a sonorous vibration, is effected, has been a matter of controversy and of doubt; the most generally received opinion being that it is accomplished by means of the thyro-arytenoid muscles; these latter are attached to the thyroid cartilage in front, and to the arytenoid behind. Now, without analysing the action of these muscles, in order to ascertain how far their contractions could influence the parallel condition of the cords, it may, however, be stated, that inasmuch as the muscles and cords are attached to the same cartilages, the action of the muscles will approximate the cartilages, and consequently relax the vocal cords, a condition incompatible with the production of high notes; so that, even supposing these muscles to be capable of effecting the necessary adjustment when a deep note is produced, they could not be used in the production of a high intonation, a certain amount of tension of the vocal cords being, under these circumstances, required. The thyro-arytenoid is a most important muscle of the larynx; it can, in a marked degree, influence the condition of the vocal cords, and is, no doubt, called into action every moment, in regulating the varied and constantly changing tension of the vocal cords; but that it is capable of producing the required parallel position of the cords cannot, we consider, be maintained; besides, it would constitute an anatomical eccentricity that a motion so essential to the function of the larynx that the mere suspension or interruption of it would be attended with total loss of voice,—it would appear, at least, very unlikely that this motion should not have a special mechanical arrangement constructed for its performance, but that this important office should be delegated to a muscle having a variety of other functions to fulfil.

"The vocal cords are attached, as was before stated, to the thyroid cartilage in front, to the anterior spur of the arytenoid behind; but the arytenoid being smaller and by far more moveable than the thyroid cartilage, a correct knowledge of the motions which can be communicated to the arytenoid cartilages by the laryngeal muscles must be first obtained, before we can estimate the various conditions of the vocal cords.

"The principal motions which are enjoyed by the arytenoid cartilages are the following:—they can be drawn forward, backward, rotated on their vertical axis, or they can revolve on a horizontal axis corresponding to the direction of the anterior spurs. The effects produced on the vocal cords by these motions will be as follows:—the forward motion will relax, and the backward movement will stretch the vocal cords; the rotation in a direction outwards on the vertical axes will separate, and the rotation inwards will approximate the vocal cords; the rotation on the horizontal axes inwards and outwards will cause the anterior spur to revolve, and to carry with it the vocal cord, which will thus alternately incline towards and from the cord of the opposite side.

"In consequence of the articular surfaces in the cricoid cartilage, for the accommodation of the arytenoid, being formed more on the external than the internal surface of the cartilage, the arytenoid cartilages are not seated in an erect position; the axes of the cartilages are consequently divergent, so that the apices are separated from each other above by a considerable interval; and in this state, which is that of repose of the organ, the planes of the vocal cords also diverge from each other. Now, the parallel position of the cords to a column of air ascending through the trachea admits of being restored by a rotation inwards of the arytenoid cartilages on their horizontal axes, which motion will cause the outer spur of the arytenoid to describe an arc of a circle in a direction upwards, and the apex to describe a similar motion in a direction inwards. We shall now proceed to examine the apparatus which we conceive to be capable of effecting this movement.

" The concave posterior surfaces of the arytenoid cartilages are occupied in the recent state by a muscle called the arytenoid; the fibres of this muscle pass transversely from the outer edge of one cartilage to a similar position on the opposite, and the action of the muscle is to approximate the posterior internal margins of the arytenoid cartilages, and to separate the anterior spurs; or, in other words, to rotate the arytenoid cartilages on their vertical axes in a direction outwards. But, in addition to these fibres, there are others which are usually denominated the oblique arytenoid muscles; it is to these latter that I wish *to direct your especial attention.* The arrangement of these muscular bands is as follows:—one set of fibres passes from the *apex* of the right cartilage to the *extreme* outer *angle* of the base of the left, and another band of fibres passes in a similar manner from the apex of the left to the base of the right; the two bands of fibres forming a crucial intersection on the posterior surfaces of the arytenoid cartilages. The oblique arytenoid muscles, being thrown into action, produce a rotation of the arytenoid cartilages on their horizontal axes; their apices are drawn inwards and approximated, while the outer margin of the base of each is at the same time elevated, and the anterior spurs consequently undergo a rotation inwards: the vocal cords are thus brought into the desired state of parallelism, and so, by this simple arrangement, the conditions necessary for the production of a sonorous vibration are fulfilled.

" It should be observed, however, that although the oblique arytenoid muscles appear to be the *principal*, they ar not the *sole* agents in producing the desired adjustment of th cords. The thyro-arytenoid, under certain circumstance may assist, and also the crico-arytenoid lateralis, as well a the superior fibres of the transverse arytenoid muscle.

“ The general form of lever used in the human body is lever of the third order, with the muscular insertion so clos to the fulcrum, that power is altogether sacrificed to velocity but in the instance of the rotation of the arytenoid cartilag upon its horizontal axis, a bent lever of the first order is used, i which there is a great augmentation of power. The extremit of the vertical arm of the lever is at the apex, and of the horizontal arm at the outer angle of the base of the cartilage but those two points correspond precisely to the attachment of the oblique arytenoid muscles; and it may be furthe stated that the incidence of the muscles on the cartilages i most favourable, so that in this particular instance there i scarcely any loss of muscular power. And lastly, it may b observed, that if we do not assign to the oblique arytenoi muscles the special use which we have now delegated to them they do not appear capable of producing any other motion tha could not have been equally well, or indeed more efficientl performed, by the transverse arytenoid muscles.”

The following letter from Sir William R. Hamilton wa read, giving some general expressions of theorems relating t surfaces, obtained by his method of quaternions:

“ The equation of a curved surface being put under th form

$$f(\rho) = \text{const.}:$$

while its *tangent plane* may be represented by the equation,

$$df(\rho) = 0,$$

or

$$\mathrm{S}\,.\,\nu d\rho = 0,$$

if $d\rho$ be the vector drawn to a point of that plane, from the point of contact; the equation of *an osculating surface of the second order* (having complete contact of the second order with the proposed surface at the proposed point) may be thus written:

$$0 = df(\rho) + \tfrac{1}{2}d^2 f(\rho);$$

(by the extension of Taylor's series to quaternions); or thus,

$$0 = 2\mathrm{S}\,.\,\nu d\rho + \mathrm{S}\,.\,d\nu d\rho,$$

if

$$df(\rho) = 2\mathrm{S}\,.\,\nu d\rho.$$

"The *sphere, which osculates in a given direction*, may be represented by the equation

$$0 = 2\mathrm{S}\,\frac{\nu}{\Delta\rho} + \mathrm{S}\,\frac{d\nu}{d\rho};$$

where $\Delta\rho$ is a chord of the sphere, drawn from the point of osculation, and

$$\mathrm{S}\,\frac{d\nu}{d\rho} = \frac{\mathrm{S}.d\nu d\rho}{d\rho^2} = \frac{d^2f(\rho)}{2d\rho^2}$$

is a scalar function of the versor $\mathrm{U}d\rho$, which determines the direction of osculation. Hence the important formula:

$$\frac{\nu}{\rho - \sigma} = \mathrm{S}\,\frac{d\nu}{d\rho};$$

where σ is the vector of the centre of the sphere which osculates in the direction answering to $\mathrm{U}d\rho$.

"By combining this with the expression formerly given by me for a normal to the ellipsoid, namely

$$(\kappa^2 - \iota^2)^2\,\nu = (\iota^2 + \kappa^2)\,\rho + \iota\rho\kappa + \kappa\rho\iota,$$

the known value of the curvature of a normal section of that surface may easily be obtained. And for *any* curved surface, the formula will be found to give easily this general theorem, which was perceived by me in 1824; that if, on a normal plane OPP′, which is drawn through a given normal PO, and through any linear element PP′ of the surface, we project the infinitely near normal P′O′, which is erected to the same surface at the end of the element PP′; the projection of the near normal will cross the given normal in the centre O of the sphere which osculates to the given surface at the given point P, in the direction of the given element PP′.

"I am able to shew that the formula

$$0 = \delta S \frac{d\nu}{d\rho},$$

which follows from the above, for determining the directions of osculation of the greatest and least osculating spheres, agrees with my formerly published formula,

$$0 = S . \nu d\nu d\rho,$$

for the directions of the lines of curvature.

"And I can deduce Gauss's *general* properties of geodetic lines by showing that if σ_1, σ_2 be the two extreme values of the vector σ, then

$$\frac{-1}{(\rho-\sigma_1)(\rho-\sigma_2)} = \text{measure of curvature of surface} = \frac{1}{R_1 R_2}$$

$$= \frac{d^2 T\delta\rho}{T\delta\rho . d\rho^2};$$

where d answers to motion along a normal section, and δ to the passage from one near (normal) section to another; while S, T, and U, are the characteristics of the operations of taking the scalar, tensor, and versor of a quaternion: and the variation δv of the inclination v of a given geodetic line to a variable normal section, obtained by passing from one such section to a near one, without changing the geodetic line, is expressed by the analogous formula,

$$\delta v = -\frac{dT\delta\rho}{Td\rho}."$$

March 16th, 1849.

REV. HUMPHREY LLOYD, D. D., President, in the Chair.

The Secretary of the Academy read the following Report:

During the past year, no event of unusual importance has occurred in the history of the Academy. The interest taken by the Members in the welfare of the Academy continues unabated, and is evinced as well by their large attendance at the Meetings as by the many valuable papers contributed to our Proceedings and to the Transactions.

Twenty-one new Members have been elected during the year now closed; and the Academy have also elected as Honorary Members, in the section of Antiquities, the Chevalier Bunsen, M. Thomsen, of Copenhagen, and M. Botta, of Paris.

The names of the ordinary Members elected during the year are as follow:

William Armstrong, Esq.
Michael Barry, Esq.
Rev. Joseph Fitzgerald.
Rev. William Graham.
James Christopher Kenny, Esq.
Capt. W. E. D. Broughton, R. E.
Ven. Archdeacon T. P. Magee, LL. D.
Andrew Graham, Esq.
Viscount Dungannon.
John Bell, Esq.
Rev. James Bewglass, LL. D.
Rev. Edward Dillon.
John Carley, Esq.
Jonathan Pim, Esq.
John Purser, Esq.
John L. Rickards, Esq., C. E.
Henry Smith, Esq., C. E.
Maurice Colles, Esq.
Rev. John Magrath, LL. D.
Jeremiah J. Murphy, Esq.
William Ogilby, Esq.

The Academy has lost by death during the past year the following Honorary Members:

James Cowles Pritchard, Esq., M. D., elected 1836.
J. Jacob Berzelius, elected 1829.

Notices of these eminent individuals having already appeared in several literary and scientific journals, it is not necessary for the

Council to pass any eulogium on men so well known, and whose memory will long be cherished in the world of letters.

The Academy has lost four ordinary Members during the past year, three of whom were among the oldest Members of this Academy.

1. The Rev. George Miller, D. D., died October 6, 1848, at a very advanced age, having retained the full powers of his active mind to the last. Dr. Miller was fifty-eight years a Member of this Academy, having been elected in the year 1790. He was for many years a Member of Council, and one of our Secretaries. His name is well known in English literature by his Philosophy of History and other works. Dr. Miller was elected a Fellow of Trinity College in 1789; he retired on the living of Derryvollan in 1804, which preferment he held, in conjunction with the head mastership of the school of Armagh, to the day of his death.

2. The Right Rev. Samuel Kyle, D. D., died May 18, 1848. He was elected a Member of the Academy in 1802, has served for many years in the Council, and filled the office of Secretary. He was also a distinguished ornament of the University, having been elected a Fellow of Trinity College in 1798; and having been subsequently for many years Provost of that College. He was consecrated Bishop of Cork and Ross in 1831, and afterwards, on the death of Bishop Brinkley, was translated to Cloyne, retaining his jurisdiction over the former dioceses, according to the provisions of the Act of Parliament which suppressed the temporalities of Cork and Ross.

3. The Right Hon. Maurice Fitzgerald, Knight of Kerry, died March 7, 1849. He was another of our oldest surviving Members, having been elected in 1796. He was the eldest son of Robert, Knight of Kerry, by his third wife, Catharine, daughter of Lancelot Sandes, Esq., and was born 29th December, 1774. Mr. Fitzgerald sat as representative for the borough of Ardfert, in the Irish Parliament, and was one of the Members appointed by the Act of Union to represent the county of Kerry in the first imperial Parliament of the united kingdom. He died at Glanleam, near Valentia, in the seventy-fifth year of his age.

4. James Thompson, Esq., LL. D., of Glasgow, died on the 12th of January last. He has been a Member of this Academy since the year 1841, but is well known from the many valuable elementary books of instruction in the mathematical sciences which he has published during the last thirty years. Dr. Thompson was connected with the Belfast Institution as Professor of Mathematics in the College department, as well as Master of the Mathematical and Mercantile School, since the opening of that institution in 1814. In 1832 he removed to Glasgow, having been elected Professor of Mathematics to that University at the close of the preceding year. He died in the sixty-third year of his age, of a disease which appeared at first to have many of the symptoms of the cholera then prevalent at Glasgow.

During the academic year which is just closed, Medals have been awarded by the Council to the following gentlemen, for their valuable contributions to literature and science:

Sir William R. Hamilton, LL. D.;
The Rev. Samuel Haughton, F. T. C. D.;
The Rev. Edward Hincks, D. D.; and
John O'Donovan, Esq.

The President's Address on the delivery of the Medals to these distinguished Members of the Academy having been printed in the Proceedings of the Academy, it is unnecessary for the Council, in this brief summary of the events of the year, to recapitulate the grounds upon which this well-merited honour was conferred.

The Museum has received some important additions, of which a list will be given as an Appendix to this volume; among these may be noticed the following:—The Academy are indebted to the Shannon Commissioners for another donation of great interest. A collection of Ogham stones, from Dingle, presented by Mr. Hitchcock, is also a donation of much value. Some swords and other weapons, believed to be Danish, which were found at Island Bridge, have also been presented by Mr. Richard Young.

But the most interesting addition made to the Museum has been that which was received from the King of Denmark and the Society of Northern Antiquaries of Copenhagen. This collection consists of some articles of great interest, and of particular importance from the light they throw on the history of the aboriginal inhabitants of Denmark, as well as on the antiquities which belong to the period of the Danish occupation of Ireland. It contains, also, some extremely beautiful casts, which, for the purpose of comparison, are as valuable to the student as the original objects.

It is much to be desired that a closer correspondence could be established between the principal Museums of national antiquities in Europe, by an interchange of casts, drawings, and descriptive catalogues. Nothing would have a greater tendency to promote antiquarian science, and to establish fixed principles from which inferences of the utmost importance respecting the migrations and early history of the human race might be derived. With a view to promote this object, the Council have already formed a pictorial Catalogue of the Museum, and they have long been desirous to prepare for publication a descriptive Catalogue. They have the gratification of stating now, with respect to the latter object, that Dr. Petrie has kindly undertaken to carry out their views by compiling a short Catalogue of the most important articles of the collection, including especially such as are in their nature unique, and such as are *types* of a class.

The same gentleman has also undertaken, at the request of the Committee of Antiquities, to draw up a detailed account of the excavations of the ancient tumulus of Dowth, and to present it to the Academy in the form of a Memoir, with a view to its publication in the Transactions.

The Library, during the past year, has received several donations, and has also been increased by a few purchases. A list of both will be given in the Appendix to the present volume of the Proceedings.

IT WAS RESOLVED,—That the Report of the Council be adopted, and printed in the Proceedings.

The Ballot for the annual election having closed, the Scrutineers reported that the following gentlemen were elected Officers and Council for the ensuing year:

President.—Rev. Humphrey Lloyd, D. D.

Treasurer.—Robert Ball, Esq.

Secretary to the Academy.—Rev. James H. Todd, D. D.

Secretary to the Council.—Rev. Charles Graves, A. M.

Secretary of Foreign Correspondence.— Rev. Samuel Butcher, D. D.

Librarian.—Rev. William H. Drummond, D. D.

Clerk and Assistant Librarian.—Edward Clibborn.

Committee of Science.

Rev. Franc Sadleir, D. D., Provost; James Apjohn, M. D.; Robert Ball, Esq.; Sir Robert Kane, M. D.; George J. Allman, M. D.; Sir William R. Hamilton, LL.D.; Rev. Samuel Haughton, A. M.

Committee of Polite Literature.

The Archbishop of Dublin; Rev. William H. Drummond, D. D.; Rev. Charles W. Wall, D. D.; John Anster, LL. D; Rev. Charles Graves, A. M.; Rev. Samuel Butcher, D. D; Rev. Nicholas J. Halpin.

Committee of Antiquities.

George Petrie, LL. D., R. H. A,; Rev. James H. Todd, D. D; J. Huband Smith, A. M.; Captain Thomas A. Larcom, R. E.; F. W. Burton, Esq., R. H. A.; Samuel Ferguson, Esq.; Aquilla Smith, M. D.

The President then appointed, under his hand and seal, the following Vice-Presidents:

His Grace the Archbishop of Dublin; Rev. Franc Sadleir, D. D., Provost of Trinity College; Rev. Charles W. Wall, D. D.; John Anster, LL. D.

The following paper was communicated by Dr. Aldridge:

"In the year 1846, it was stated by Dr. Budge that when the whites of eggs were treated with alcohol, and a solution of potassa and some drops of a solution of sulphate of copper were added to the filtered spirituous liquid, red oxide of copper became deposited upon the application of heat; and from this behaviour he inferred the probability that sugar was a constant constituent of the white of eggs. Baron Liebig, however, considered that this reaction only showed that some deoxidizing substance was removed by the alcohol, and that, before the existence of sugar in the white of eggs could be admitted as a fact in science, it would be necessary that this substance should be extracted and examined.

" I have now to announce the discovery and isolation by me of sugar, identical in properties with that obtained from grapes, in the white of the egg of the domestic hen. It may be obtained by beating the unboiled whites of eggs into a smooth pulp, with an equal bulk of rectified spirits of wine, specific gravity 0·850, and then applying heat; when, as the mixture is approaching the boiling point of alcohol, it will suddenly separate into two portions, the coagulated albumen and the spirit, now become of a straw colour. By straining and strongly pressing the albumen, the greater part of the spirituous liquid can be obtained distinct; and this, being evaporated over a water bath, will yield a succession of pellicles, transparent and gelatinous in appearance, which, according as they form, will have to be removed and preserved. The colour of these pellicles, at first pale yellowish, becomes deeper as the evaporation proceeds, and towards the end becomes reddish brown. When one of the pellicles is immersed for a short time in strong nitric acid, and then transferred into water of ammonia, it changes to a deep orange colour, a character in which it agrees with albumen, fibrine, and caseine, although it differs from those substances in having been obtained by evaporation from a spirituous solution, which solution is not precipitable by acids. It is to be remarked that the spirituous solution is strongly alkaline. The various pellicles obtained by the evaporation of the spirituous liquid are subsequently to be triturated with rectified spirit, then boiled and filtered. The filtered liquid is colourless, and upon being evaporated to the consistence of a thick syrup, and allowed to cool, deposits whitish grains on the sides and bottom of the vessel. These grains, and the syrup from which they deposit, have a taste, at first intensely sweet, but rapidly followed by a saline after-taste. A little of the syrup, when boiled with an equal bulk of potash water, acquires immediately a deep claret colour. Some of the syrup having about half its bulk of potash water added to it, and then a little hydrated oxide of copper, the latter dissolves with the production of a fine red colour; but after being exposed for some time to the air, the solution decomposes, and a precipitation of red oxide of copper takes place. A little of the syrup being added to water of potash, in which hydrated oxide of copper was diffused by the previous addition of a drop or two of solution of sulphate of copper, the precipitate immediately redissolves, and upon the application of heat red oxide of copper becomes precipitated. From these properties and tests, I consider that we are justified in concluding that, by the process indicated, grape sugar, contaminated with certain salts, is capable of being extracted from the whites of eggs.

"The usual tests for grape sugar are capable of affording very marked indications with the white of egg, although somewhat modified, probably from the presence of other constituents present in the organ. Thus, Moore's test causes the production of a deep amber colour, as well marked as with the urine in most cases of diabetes mellitus. Capezzuoli's test affords a beautiful pink solution, which gradually decomposes, and throws down a *brown* precipitate. Tromsdorf's test furnishes a deep *red* solution, which precipitates *brown* upon being boiled. The cause of these reactions is capable of being removed from the albumen of the white of egg, by the agency of alcohol, and will then become concentrated in the alcoholic extract.

"I was desirous of ascertaining whether the presence of sugar in the white of egg might not be due to a commencing putrefaction of the albumen; but I have found as manifest indications of sugar in a fresh laid egg as in one that had been kept for several days."

APRIL 9TH, 1849.

REV. HUMPHREY LLOYD, D. D., PRESIDENT,
in the Chair.

Daniel Brady, M. D.; Benjamin Lee Guinness, Esq.; Henry Kennedy, M. B.; and Hon. Thomas Vesey, M. P.; were elected members of the Academy.

Mr. Donovan read a paper on the Preparation of Phosphorus.

The early processes of Hellot, Dolfuss, Henckel, Margraaf, and others, were first commented on, and their disgusting, troublesome, and inefficient nature pointed out.

At this time the price of phosphorus was enormous. Mr. Boyle induced a chemist to adopt a new method, which enabled him to produce phosphorus so abundantly, that its price fell to six guineas per ounce. At present it may be purchased for half as many shillings.

But when Gahn discovered that the earthy part of bone consists of phosphate of lime, a more abundant source of phosphorus was made known to chemists. From two pounds of bone ashes, Wiegleb obtained ten drachms and a half of phosphorus; Dolfuss, rather less than five drachms; and Pelletier sometimes so much as three ounces.

Observations were made on the practical difficulties, defects, and great trouble of the bone-ash process; and remedies were pointed out. It was shown that bones are procurable in various commercial states, viz., in coarse powder, for the purposes of agriculture; burned to blackness in the process for obtaining carbonate of ammonia; or in small particles from the lathe of the bone turner. In all these states bones afford phosphate of lime; but there are other sources, the most abundant of which are the horns of certain animals. The result of some trials was stated, from which it appeared that recent sheep bone (the leg), when burned to whiteness, afforded 38·71 per cent. of earthy matter; and recent ox-ribs, 37·14 per cent. In neither case were the moisture and fatty matter previously withdrawn, and this is the cause of the difference between these estimates and those that have been hitherto published. With regard to horn, the incineration to whiteness of shavings of hartshorn returned, on an average of many trials, 62 per cent. of phosphate of lime.

These different forms of bone and horn present us with phosphate of lime, in states which possess different advantages; some hold out the inducement of cheapness, some of facility in employing them; all of them answer the purpose. Hartshorn shavings, beside phosphate of lime, contain a light, highly nutritious, and most agreeable jelly, which has found its way to the kitchen, the nursery, and the sick room, and which may be preserved after the shavings have yielded their earth.

In order to remove the animal matter from the earthy portion of bones, the process of calcination is resorted to, but this is uneconomical and troublesome. It is better and easier to withdraw the earthy portion from the animal matter by digestion in very dilute nitric acid; the earthy salts will be thus dissolved away, and the cartilage will remain unaltered. The phosphoric acid may be withdrawn from the solution by means of a salt of lead. Chloride of lead does not succeed, the nitrate will not be more successful, but the acetate answers perfectly. The cartilage which remains may be converted to a variety of purposes, as for making glue and size.

On economical grounds, bones, not burned, but crushed between rollers for agricultural purposes, were recommended as the proper source from which phosphorus, on the large scale, is to be procured. On the small scale, shavings of hartshorn were stated to be more convenient.

Estimates were then given of the quantities of the materials to be employed under various circumstances, with their cost, and the mode of manipulation. Directions were given for recovering the acetic acid disengaged in the process, and reconverting it into acetate of lead for future precipitations of bone solutions. An easy method of drying and reducing the volume of the phosphate of lead obtained was described. The paper concluded with two formulæ for obtaining phosphorus, founded on the facts stated, which it was conceived reduce the trouble and cost of preparing that article to the lowest scale of which it is susceptible.

Mr. H. L. Renny read a paper on the effects of moisture as affecting the barometric measurement of heights.

"Whereas Dr. Apjohn has inserted in a note of a paper read by him before the Academy, and published in vol. ii. of the Proceedings of the Academy (1840–1844), at page 565, an expression for the correction due to the hygrometric state of the atmosphere, in the formulæ for the measurement of heights by the barometer, which expression, as the note states, was furnished to Dr. Apjohn by myself, I hope I do not request unnecessarily the attention of the Academy to the process by which I obtained the said formula.

$$\left.\begin{array}{l}\text{Let } p \text{ be pressure,}\\ f \text{ be the force of aqueous vapour,}\end{array}\right\}\text{at the lower station.}$$

$$\left.\begin{array}{l}p' \text{ be pressure,}\\ f' \text{ be the force of aqueous vapour,}\end{array}\right\}\text{at the upper station.}$$

$$\left.\begin{array}{l}\pi \text{ be pressure,}\\ F \text{ be the force of aqueous vapour,}\end{array}\right\}\begin{array}{l}\text{at any station what-}\\ \text{ever, } \pi \text{ and } F \text{ being,}\\ \text{of course, variable.}\end{array}$$

n be a number extremely great.

δ be a quantity indefinitely small.

Let r be ratio of a geometric series.

M be $(= 0 . 43494$, &c.) modulus of common logarithms.

v be hypothetic distance between stations, upon supposition that the atmosphere be perfectly free from aqueous vapour.

v' be actual distance between stations, taking, of course, into consideration the hygrometric state of the atmosphere.

Now let us suppose the actual distance between the stations $(= v')$ to be divided into an extremely great number of equally thin parts or strata, then $\frac{v'}{n} =$ actual thickness of each equal stratum of air; also, $\frac{v'}{n} \times \frac{\pi - F}{\pi}$ is the general expression for the hypothetic thickness of any stratum, upon supposition that the atmosphere be perfectly free from aqueous vapour.*

" Now, adopting a notation (similar to that employed for the upper station), relative to the pressure and force of vapour, for the successive strata of air, descending from the upper to the lower station, we have for expression of the hypothetic thicknesses of the various strata, upon supposition that the air be perfectly dry,

$$\frac{v'}{n} \times \frac{p' - f'}{p'}; \quad \frac{v'}{n} \times \frac{p'' - f''}{p''}; \quad \frac{v'}{n} \times \frac{p''' - f'''}{p'''}; \quad \frac{v'}{n} \times \frac{p'''' - f''''}{p''''}; \text{ \&c.}$$

Now, the whole being equal to the sum of its parts,

$$v \text{ (– the hypothetic distance between the stations)} = \frac{v'}{n} \times \frac{p' - f'}{p'} + \frac{v'}{n} \times \frac{p'' - f''}{p''} + \frac{v'}{n} \times \frac{p''' - f'''}{p'''}; + \text{\&c. \&c.}$$

that is,

$$v = \frac{v'}{n} \times \left\{ \overline{1 - \frac{f'}{p'}}, + \overline{1 - \frac{f''}{p''}} + \overline{1 - \frac{f'''}{p'''}} + \overline{1 - \frac{f''''}{p''''}} + \text{\&c.} \right\}$$

But p', p'', p''', p'''', &c., form a geometric series, according to the well-known principle of barometric measurements; and b consulting the table of forces of aqueous vapour, in the ap pendix to Turner's Chemistry,* I find that the forces of va pour form (*quam proxime*) a geometric series, when the de grees of temperature form an arithmetic one. Let us, therefor take the geometric mean of the forces of aqueous vapour at th stations $= \sqrt{(f \times f')}$, and indicating this quantity F', and instea of the variable forces of vapour in the last equation, let u employ the quantity F' (which will be practically sufficientl accurate so long as the correction for the temperature of the ai as shown by the detached thermometers, continues, as at pre sent, so liable to error), we shall change our fundamental equa tion, as given above, into

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* *Vide* paper by Dr. Apjohn, Proceedings Royal Irish Academy, vol. ii. p. 563; or p. 105, same volume.

$$v = \frac{v'}{n} . \left\{ \overline{1 - \frac{F'}{p'}} + \overline{1 - \frac{F'}{rp'}} + \overline{1 - \frac{F'}{r^2 p'}} + \overline{1 - \frac{F'}{r^3 p'}} + \&c. \ldots \overline{1 - \frac{F'}{r^{n-1} p'}} \right\}$$

or

$$v = \frac{v'}{n} \left\{ n - F \left(\frac{1}{p'} + \frac{1}{rp'} + \frac{1}{r^2 p'} + \frac{1}{r^3 p'} + \&c. \ldots \frac{1}{r^{n-1} p'} \right) \right\}.$$

Summing the geometric series of the right hand of the equa tion last obtained, and modifying somewhat the rest of it, w have

$$v = v' \left\{ 1 - F' . \frac{1}{n} . \left(\frac{\frac{1}{p'} - \frac{1}{r^n p'}}{1 - \frac{1}{r}} \right) \right\}. \qquad (A$$

But $r^{n-1} p' = p$; eliminating r from equation (A), by means o this last equation, we have

$$v = v' \left\{ 1 - F, \frac{\frac{1}{p'} - \frac{1}{p'} \left(\frac{p'}{p} \right)^{\frac{n}{n-1}}}{n \left(1 - \left(\frac{p'}{p} \right)^{\frac{1}{n-1}} \right)} \right\}. \qquad (B$$

Let us now seek the limit of the right hand side of equa tion (B). By changing (n), a quantity extremely great, into (n'), a quantity indefinitely great, we have $n' = (n' - 1)$; also, $\frac{n'}{n' - 1} = 1$. Moreover, p' being less than p, $\frac{p'}{p}$ is a fraction, and the limit of $\left(\frac{p'}{p}\right)^{\frac{1}{n'}} =$ unity, which is expressed in algebraic language thus,

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* Seventh Edit. pp. 1248–49.

$$\left(\frac{p'}{p}\right)^{\frac{1}{n-1}} = 1 - \delta;$$

consequently

$$n' . \left\{1 - \left(\frac{p'}{p}\right)^{\frac{1}{n'-1}}\right\} \text{ (when we take its limits)} = n'(1 - \overline{1-\delta}) = n'\delta.$$

Now, whereas

$$\left(\frac{p'}{p}\right)^{\frac{1}{n'}} = \overline{1 - \delta}; \log\left(\frac{p'}{p}\right) \times \frac{1}{n'} = \log. \overline{1-\delta} = -M\left\{\frac{\delta}{1} + \frac{\delta^2}{2} + \frac{\delta^3}{3} + \&c.\right\};$$

or

$$n' = \frac{\log\frac{p'}{p}}{-M\left(\frac{\delta}{1} + \frac{\delta^2}{2} + \frac{\delta^3}{3} + \&c.\right)};$$

or

$$n'\delta = \frac{\log\frac{p'}{p}}{-M - M\left(\frac{\delta}{2} + \frac{\delta^2}{3} + \frac{\delta^3}{4} + \&c.\right)};$$

or

$$n'\delta = \frac{\log.\frac{p}{p'}}{M + M\left(\frac{\delta}{2} + \frac{\delta^2}{3} + \frac{\delta^3}{4} + \&c.\right)}.$$

Taking limits, by omitting δ and its powers in the right hand side of this last equation, we have the limit of $n'\delta$, or

$$n'\left\{1 - \left(\frac{p'}{p}\right)^{\frac{1}{n-1}}\right\} = \frac{\log.\frac{p}{p'}}{M};$$

substituting this value in the right hand side of equation (B), also simplifying the numerator, we have

$$v = v' \cdot \left\{ 1 - F \frac{\left(\frac{1}{p'} - \frac{1}{p}\right)}{\frac{\log \frac{p}{p'}}{M}} \right\};$$

therefore
$$v' = v \times \frac{1}{1 - F \cdot \frac{\frac{1}{p'} - \frac{1}{p}}{\frac{1}{M} \cdot \log \frac{p}{p'}}}.$$

Modifying the right hand side of this last equation, by dividing each term by the coefficient of F, we have

$$v' = v \cdot \frac{\frac{\frac{1}{M} \log \frac{p}{p'}}{\frac{1}{p'} - \frac{1}{p}}}{\frac{\frac{1}{M} \log \frac{p}{p'}}{\frac{1}{p'} - \frac{1}{p}} - F}.$$

Let
$$\frac{\frac{1}{M} \cdot \log \frac{p}{p'}}{\frac{1}{p'} - \frac{1}{p}} \text{ be } P;$$

then $v' = v \times \frac{P}{P - F}$; being the formula given in note, Proceedings of Royal Irish Academy, vol. ii. p. 565; F being $\sqrt{(f \times f')}$, or the geometric mean of forces of aqueous vapour.

N. B.—The approximate expression given by Dr. Apjohn,[*] viz.,

$$v' = v \times \frac{\sqrt{\{(p - f') \times (p' - F'')\}}}{\sqrt{\{(p - f''') \times (p' - F'')\}} - \tfrac{1}{2}(f'' + F')},$$

in which Dr. Apjohn employs the geometric mean of pressures minus the forces of aqueous vapour, instead of P, the more correct expression, will answer very well indeed for hills only 1000 feet high, and under that height. In fact, for hills of such height, Dr. Apjohn's formula is astonishingly close to the more correct expression. But for hills 2000 feet high and upwards, Dr. Apjohn's approximate formula fails, inasmuch as the error varies from 10 to 20 per cent. of the correction due to the hygrometric state of the air. Now, as Dr. Apjohn justly observes[†] that the correction due to the hygrometric state of the air amounts to at least 30 feet in hills 2000 feet high, the error of his formula will vary from 3 to 6 feet, according to the greater or smaller quantity of watery vapour in the atmosphere. Indeed in hills of 1000 feet high and less, instead of the geometric mean of pressures minus the forces of aqueous vapour, we may employ the arithmetic mean of pressures with perfect practical safety, viz.:

$$v' = v \times \frac{\tfrac{1}{2}(p + p')}{\tfrac{1}{2}(p + p') - \tfrac{1}{2}(f + f')} = v \times \frac{(p + p')}{(p + p') - (f + f')}.$$

N. B.—The formula given by Mr. Renny to Dr. Apjohn, viz.,

$$v' = v \times \frac{P}{P - F},$$

P being

$$\frac{\frac{1}{M}\log\frac{p}{p'}}{\left(\frac{1}{p'} - \frac{1}{p}\right)},$$

is not rigidly or mathematically correct; because Mr. Renny's fundamental equation,

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[*] Proceedings Royal Irish Academy, vol. ii. p. 563.

[†] Ibid. vol. ii. p. 564.

$$v = \frac{v'}{n} \cdot \left\{ n - F \left(\frac{1}{p'} + \frac{1}{rp'} + \frac{1}{r^2 p'} + \frac{1}{r^3 p'} + \&c. \frac{1}{r^{n-1} p'} \right) \cdot \right\},$$

supposes that the hypothetic thicknesses of the strata of air are equal, which is not true, for they vary as $\frac{\pi - F}{\pi}$. Considering, however, that until the law of variation of temperature of the atmosphere between the stations be determinately known (which will, perhaps, never take place), the barometric formula for heights can only be approximate, it is lawful to employ the said formula as closely approximate, until, however, a more correct one be obtained.

The mathematic error thus noticed escaped Mr. Renny's attention when, six years ago, he gave the formula to Dr. Apjohn. Mr. Renny hopes, at no distant period, to obtain a formula absolutely correct, if not by series, by the integral calculus.

The Secretary of Council read the following communication from Sir William Rowan Hamilton, on an equation of the ellipsoid.

" A remark of your's, recently made, respecting the form in which I first gave to the Academy, in December, 1845, an equation of the ellipsoid by quaternions,—namely, that this form involved only *one* asymptote of the focal hyperbola,—has induced me to examine, simplify, and extend, since I last saw you, some manuscript results of mine on that subject; and the following new form of the equation, which seems to meet your requisitions, may, perhaps, be shewn to the Academy to-night. This new form is the following :

$$\mathrm{TV}\, \frac{\eta\rho - \rho\theta}{\mathrm{U}(\eta - \theta)} = \theta^2 - \eta^2. \qquad (1)$$

"The constant vectors η and θ are in the directions of the two asymptotes required; their symbolic sum, $\eta + \theta$, is the vector of an umbilic; their difference, $\eta - \theta$, has the direction of a cyclic normal; another umbilicar vector being in the direction of the sum of their reciprocals, $\eta^{-1} + \theta^{-1}$, and another cyclic normal in the direction of the difference of those reciprocals, $\eta^{-1} - \theta^{-1}$. The lengths of the semiaxes of the ellipsoid are expressed as follows:

$$a = T\eta + T\theta;\ b = T(\eta - \theta);\ c = T\eta - T\theta. \qquad (2)$$

"The focal ellipse is given by the system of the two equations

$$S.\rho U\eta = S.\rho U\theta; \qquad (3)$$

and

$$TV.\rho U\eta = 2S\sqrt{(\eta\theta)}; \qquad (4)$$

where $TV.\rho U\eta$ may be changed to $TV.\rho U\theta$; and which represent respectively a plane, and a cylinder of revolution. Finally, I shall just add what seems to me remarkable,—though I have met with several similar results in my unpublished researches,—that the focal hyperbola is adequately represented by the *single* equation following:

$$V.\eta\rho.V.\rho\theta = (V.\eta\theta)^2." \qquad (5)$$

In the same note to the Secretary, it was requested by Sir William R. Hamilton that the Academy might be informed of a theorem respecting the inscription of certain gauche polygons, in surfaces of the second degree, which he had lately communicated to the Council. This theorem was obtained by the method of quaternions, and included, as a particular case, the following:—"If the first, second, third, and fourth sides of a gauche nonagon, inscribed in a surface of the second order, be respectively parallel to the fifth, sixth, seventh, and eighth sides of that nonagon, and also to the first, second, third, and fourth sides of a gauche quadrilateral, inscribed in the same surface; then the plane containing the first, fifth, and ninth corners of the nonagon will be parallel to the plane which touches the surface at the first corner of the quadrilateral."

More generally the theorem here referred to shews that for the inscribed quadrilateral we may substitute a gauche polygon with any even number, $2n$, of sides; and for the nonagon, another gauche polygon, with $4n+1$ sides, connected with that polygon of $2n$ sides, by the same law of construction as that which had connected the nonagon with the quadrilateral; and that then the tangent plane to the surface at the first corner of the polygon of $2n$ sides, will be parallel to the plane through the first, middle, and last corners ($1, 2n+1$ $4n+1$) of the polygon of $4n+1$ sides.

The Secretary presented, from the Rev. W. C. Armstrong, an earthen sepulchral urn, found on the 17th of March last, in a field, part of Moydow glebe, county Longford; together with the jaw bone of a man whose skeleton was found near the urn. He also presented, from Mr. R. Hitchcock, a large stone-hammer, used by miners, and found near Killarney.

Several donations of books were also made to the Library, which will be found noticed in the Appendix.

Thanks were returned to the several donors.

APRIL 23RD, 1849.

SIR WILLIAM BETHAM in the Chair.

DR. Harvey made a communication respecting the nature of the Fructification of the Rhodospermatous Algæ.

"In the Rhodospermatous Algæ, or Florideæ, the fructification presents itself under two forms. *Two* sorts of reproductive bodies are produced by each species of these algæ, both sorts equally capable of germinating into a new plant, both, therefore, performing the functions of a *seed*. These reproductive bodies are never found together on the same individual, but some individuals produce one kind of fruit, some the other kind. One sort is called a *spore*, the other a *tetraspore*, because it divides at maturity into four parts or *sporules*.

"It is not reasonable to regard both these bodies as *true seeds*, because they are formed in very different manners, and because it is against the analogy of the rest of the vegetable kingdom to admit a *double* seminal system. Other plants have but *one* kind of SEED proper to each species. But other plants grow either from *seeds*, properly so called, or from *bulbs* or *buds* formed in the axils of their leaves, or out of some part of their cellular system. We may therefore admit a similar explanation of the double fructification of Rhodosperms, namely, that one of their fruits is the analogue of a *seed*, the other of a *bud;* and such is the usual explanation of the difficulty. But there will still remain unanswered the question,—which sort of fruit is the *seed*, and which is the *bud?* In flowering plants nothing would be more easy than to answer such a query, for we know that *seeds* are only formed through the action of stamens and pistils in special assemblages of organs, called flowers. But among cryptogamic plants the floral organs appear in a state so much reduced, or they are so much confounded with organs of nutrition, that it is often difficult to decide upon the true nature of the several parts. And in the present case (of the Rhodosperms) botanists have, at different times, held opposite opinions on the respective value of the *spore* and the *tetraspore*.

"Formerly the *spore* was regarded as the true *seed* (and called "primary fruit"), and the *tetraspore* as a propagulum or bud (and called "secondary fruit"). M. Decaisne originated an opposite hypothesis, alleging that the *tetraspore* was the true analogue of a *seed*, and attributing very inferior importance to the *spore*, denying its reproductive nature in some cases altogether, and in none admitting it to rank higher than a *bud* or *propagulum.* This view has been adopted by Agardh, and may be considered the notion commonly held by botanists.

"The *opposite* and older opinion is still held and defended by Areschoug, an able Swedish algologist, and, in this country, by Mr. Thwaites, of Bristol, a most expert and accomplished cryptogamic botanist, and a distinguished physiologist. These authors consider that as the spores are usually formed in special organs or *conceptacles*, accompanied by peculiar transformations and the growth of special tissues, and as the *tetraspores* are commonly dispersed through the substance of unmetamorphosed branches, the *former* have more the character of *special* reproductive bodies than the latter, and should therefore be regarded as the representatives of *seeds.* This reasoning will apply to a considerable number of cases, but not to all, for in many instances we find *tetraspores* formed in special organs, as complex in structure as the conceptacles of the *spores.*

"As far as I am concerned, I have hitherto hesitated to form or express any opinion on this puzzling matter, believing that the evidence was pretty nearly balanced, and that deductions which appear clear when we take in only a few selected cases are considerably weakened when the whole subject comes under review. I could never quite give up the seminal nature of the *spore*, yet, in many cases, I was forced to admit the high organization of the *tetraspore.* And there are cases in which it is difficult to say whether the body be a *spore* or a *tetraspore.* One of these anomalies occurs in *Corallina*, in which genus we have quadripartite *spores* (or *tetraspores*) contained in conceptacles. These bodies are, by their position, strictly analogous to the *spores* of *Polysiphonia*, and yet in their structure they have the character of *tetraspores.* Cases of this kind, and they are by no means isolated, make me very cautious of expressing a decided opinion at present on this question. Meanwhile some arguments, resting partly on analogy, partly on observation, have recently suggested themselves to me in favour of the claims of the *spore* to be regarded, at least in certain genera, as the analogue of the *seed;* and my present object is chiefly to place on record a slight outline of the argument, proposing, at a future time, to return to the subject, and treat it in the detail that its importance deserves. For, however trivial the discussion of such a question may at first sight appear, much depends on our right solution of it. It is like one of the first steps in a chain of reasoning, the wrong determination of which will vitiate all subsequent inferences. If we have incorrect notions respecting the morphology of these vegetables, all our ideas respecting them will be distorted.

" I shall, on the present occasion, confine myself to some brief remarks on the development of the frond and of the conceptacular fruit in the well-known genus *Polysiphonia.* If we examine a young, growing specimen of any species of this genus, we find that the tips of all its branches terminate in a tuft of dichotomous fibres. The branch consists of a number of cells, placed in a radiating manner like the spokes of a wheel, round a central cavity. Towards the tips of the branches these radiating cells are gradually shorter, and each cell of the last whorl or wheel is prolonged into a dichotomous fibre. This *fibre* never changes its character till it falls away, but the cells (of the branch) below it lengthen and grow wide till they assume their proper form and size. *Growth,* therefore, takes place below the *apical* fibre. Such is the case in the primary branches. When a *new* lateral branch is about to be given off from a primary one, a dichotomous fibre, similar to those at the apex of the old branch, makes its appearance opposite one of the dissepiments of the old branch. Under this fibre a cellular nucleus begins to be formed, which increases in size, and takes the character of one of the branches, new fibres being developed upon it as it acquires complexity. As such fibres are constantly met with on all the *growing* apices while the frond is in process of extension, it is not unnatural to suppose that they are actively concerned in the development they ac-company ; otherwise why should they be formed with such regularity? They are not peculiar to one species, but are found on the young fronds of all, as well on those from Cape Horn and New Holland, as on the common species of our own coasts. Similar fibres are found on the young parts of other algæ, especially of the *Sporochnoideæ* and *Dictyoteæ*, in the former of which they are evidently very essential organs; and I am of opinion that the monosiphonous ramuli of *Polysiphonia byssoides* and its allies, and of all the *Dasyæ*, are organs of a similar nature, but are in higher development in those plants than in the majority of the *Polysiphoniæ*. Imperfect as they seem to be, I am inclined to regard them as *leaves*, or the analogues of those organs.

"The only argument that occurs to me why we should not regard these fibres as acrogenous leaves is founded on their minute size and imperfect development. But this can be no valid objection to their analogical character. Even among perfect plants, such as Exogens, we often find the leaf reduced to a minute scale, while its place is supplied by a peculiar frondose development of stem, as in the Cacti, and, in a still more striking manner, in the euphorbiaceous genus *Xylophylla*. In this latter the small branches are flattened and green, like leaves, while the true leaves are reduced almost to simple fibres, and are only found on the young branches. Compared with the organization of *Xylophylla*, such leaves are incomparably less perfect than the fibres of *Polysiphoniæ*, as compared with the organization of that genus. Imperfection of development is, therefore, no valid objection to the analogy between the apical fibres and acrogenous leaves; and if this analogy be admitted, we establish the first step in our argument.

"We have in the next place to determine the morphological relation of the ceramiduim or case in which the tuft of spores is contained. This spore-case is, in all the *Rhodomeleæ* and *Chondrieæ*, simply a truncated branch of the frond; a branch diverted from its normal character, and changed into an ovate or pitcher-shaped hollow body, pierced at the apex, and containing a tuft of spores. That a ceramidium is really a metamorphosed branch is apparent from the inspection of any plant of the family; no phycologist will deny the assertion, so I shall not waste the Academy's time by proving it, but proceed to inquire what metamorphosis has taken place.

"The *ceramidium* makes its appearance, as a young branch does, on the side of an old one; or it is formed but rarely at the apex of the branch. In either case it is at first a little round knob, destitute of apical fibres. This knob gradually swells, but does not greatly lengthen, becomes urceolate or ovate, and is finally pierced at the apex. On opening it we find a tuft of fibres, with their terminal cells converted into pear-shaped spores, attached to a cellular placenta at the base of the spore-case. What metamorphosis have we here? The lengthening of the branch is stopped, and the powers of life concentrated on the elaboration of the contents of the ceramidium. The placenta at the base of the ceramidium is evidently the proper apex of the branch; if this be so, the walls of the ceramidium, as well as the stalked spores within, are probably transformations of the apical fibres. Or we may suppose an introversion of the apex to take place, analogous to what appears to occur in the Fuci; or that, the onward growth of the branch being stopped, owing to the altered condition of the apical fibres (the cause of this altered condition being a fertilization of their cells), the cellular substance continues to develope *laterally* for a time, until it have formed the walls of the conceptacle. Whichever hypothesis we adopt, I think we are warranted in regarding the tuft of spores as the metamorphosed apical fibres.

"I have already endeavoured to show the probability that the apical fibres are the analogues of leaves. If this be admitted, and that it be also admitted that the contents of the ceramidium are apical fibres diverted to another purpose, then we shall have strong analogical evidence in favour of the seminal character of the spores, for here we arrive at a clear resemblance to the metamorphosis of flowering plants. In flowering plants the *flower* is a truncated branch, and all its parts are metamorphoses of leaves; this flower produces *seeds*. In the algæ of which we speak, the ceramidium (or spore case) is a truncated branch, and its parts are modifications of the apical fibres or supposed leaves; this spore-case produces *spores*. *Seeds* in the first case, and *spores* in the second, are thus formed, so far as we can perceive, under analogous circumstances. It is therefore not unreasonable to infer that the bodies so formed are analogous to each other. The same cannot be said respecting *tetraspores*. One step in the analogy is, however, deficient. We know in what manner the germs of *seeds* are fertilized, but we have yet to learn under what circumstances this alteration in the condition of spores takes place, whether previous to the growth of the *ceramidium*, when the spore may be supposed to exist under the form of a naked ovule, or subsequent to the formation of the ceramidium, and full organization of the spore. I am not prepared with any evidence on this most obscure subject.

"I shall only further remark, as strengthening the analogy derived from the metamorphosis of flowering plants, that in *Polysiphonia* the *antheridia* (or supposed *stamens*) are formed, as the *spores* appear to be, by a metamorphosis of the cells of the apical fibres. In flowering plants we know that stamens and pistils are merely modifications of a common *type*, altered for a special purpose. And here we find that *spore* and *antheridium* have a common origin, each in the apical fibre; but *spores* are produced when the branch is metamorphosed into a conceptacle, and *antheridia* are formed on the fibres of the unchanged branches, and developed externally."

Dr. Allman, in confirmation of Dr. Harvey's views, referred to the fructification the *Charæ*, whose whorls are regarded by him as analogous to the apical fibres of *Polysiphoniæ*, described by Dr. Harvey.

Rev. Samuel Haughton communicated to the Academy an account of the late Professor Mac Cullagh's lectures on the rotation of a solid body round a fixed point, compiled from notes of his lectures.

The Secretary read a paper by Mr. Henry Henessy, "On the Influence of the Earth's figure on the Distribution of Land and Water at its Surface."

" In a paper, read before the Geological Society of Dublin, on the Changes of the Earth's Figure and Climate, resulting from causes acting at its surface, the author endeavoured to show that certain phenomena, which in some quarters were supposed to be explicable by appealing to such causes, are not at all capable of being so explained. In support of this conclusion it was stated that if, in accordance with the assumptions of the theory considered in the paper alluded to, the earth were originally a solid sphere, and if the ratio of its mean equatorial to its mean polar radius continually increased, the area of dry land at the equator, compared to its area at the poles, would also continually increase.

" To the author this proposition appeared so evident that he did not think its formal proof required to be exhibited. As, however, it subsequently seemed desirable that such a proof should be produced, he has attempted in this paper to fulfil that object.

" Besides proving the proposition in question, the author believes that he has arrived at a new result, which alone would support the views he advocated in the paper already cited.

" 1. If, in accordance with the fundamental assumptions of the theory considered in the paper referred to, the earth were originally a solid sphere, composed of concentric spherical strata of equal density, and covered with the water which now constitutes its seas and oceans, it is evident that its rotation would tend to give a spheroidal form to the surface of the fluid. If, by the action of causes at the surface of the earth, the solid sphere became gradually an oblate spheroid, the direction of the resultant of the forces acting on a particle of the fluid at its surface would be also gradually changed, and consequently the form of the surface. The distribution of the water on the earth's surface might thus be so altered as to tend in some regions to lay bare the former bed of the ocean, and in others to submerge the dry land. The following investigation shows that such a tendency would exist, and, moreover, that it would be such as to establish the truth of the proposition stated in the foregoing introductory remarks.

"2. As the causes by which the surface of the earth may have acquired a spheroidal form are assumed to act only at its surface, it follows that, except in the immediate vicinity of that surface, its constitution must remain unchanged. It will, therefore, consist of a sphere composed of concentric spherical strata surrounded by a solid mass, having its mean density equal to that of the surface stratum of the sphere, and included between a spherical and spheroidal surface, together with the fluid mass covering the latter. The surface of the fluid being spheroidal, and the surface bounding the exterior solid mass having necessarily a small ellipticity, we may suppose that of the former surface small. In the succeeding investigation the second powers of these ellipticities shall therefore be neglected.

"The forces acting on a particle at the surface of the fluid in equilibrium are:

"(1.) Attraction of the solid sphere with the radius a_2 and mean density D.

"(2.) Attraction of the superficial mass with the density D_1, bounded inwardly by the spherical surface with the radius

a_2, and outwardly by the spheroidal surface with the mean radius a_1.

"(3.) Attraction of the mass of fluid bounded inwardly by the spheroidal surface having the mean radius a_1, and outwardly by the spheroidal surface, having the mean radius a.

"(4.) Centrifugal force.

"If U_0, U_1, U_2, &c., represent such functions of the coordinates of the spheroid, that on the substitution of each successively for U_i in the following well-known differential equation it will be satisfied,

$$\frac{d\,.\sin\theta\dfrac{dU_i}{d\theta}}{\sin\theta d\theta}+\frac{1}{\sin^2\theta}\,\frac{d^2U_i}{d\omega^2}+r\,\frac{d^2rU_i}{dr^2}=0\,;$$

and if we use the notation of M. de Pontécoulant for all quantities not otherwise specified, we shall have, for the functions on which the forces above enumerated depend,*

$$\left.\begin{array}{ll}
(1) & \dfrac{4\pi a_2^3D}{3r} \\
(2) & \dfrac{4\pi}{3r}(a_1^3-a_2^3)D_1+\dfrac{4\pi D_1\alpha_1a_1^3}{r}\left(\dfrac{a_1^2}{5r^2}U_2+\dfrac{a_1^3}{7r^3}U_3+\&c.\right) \\
(3) & \dfrac{4\pi}{3r}(a^3-a_1^3)+\dfrac{4\pi}{r}\left\{\alpha a^3\left(\dfrac{a^2}{5r^2}Y_2+\dfrac{a^3}{7r^3}Y_3+\&c.\right)\right. \\
 & \qquad\qquad\left.-\,\alpha_1a_1^3\left(\dfrac{a_1^2}{5r^2}U_2+\dfrac{a_1^3}{7r^3}U_3+\&c.\right)\right\} \\
(4) & \tfrac{1}{3}gr^2-\tfrac{1}{2}gr^2(\cos^2\theta-\tfrac{1}{3}).
\end{array}\right\}\ (a)$$

U_0, U_1, Y_0, Y_1, being omitted by the properties of such functions,† and α_1 being a small quantity depending on the ellipticity of the spheroidal surface bounding the solid mass. The equation of equilibrium of the fluid surface will therefore be

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* Pontécoulant, Theorie Analytique du Systeme du Monde, livre v. No. 32.

† Ibid.

$$C = \frac{4\pi}{3r}\{a^3 + a_1^3(D_1 - 1) + a_2^3(D - D_1)\}$$

$$+ \frac{4\pi}{r}\left\{ aa^3\left(\frac{a^2}{5r^3}Y_2 + \frac{a^3}{7r^3}Y_3 + \&c.\right)\right.$$

$$\left. + a_1 a_1^3(D_1 - 1)\left(\frac{a_1^2}{5r^3}U_2 + \frac{a_1^3}{7r^3}U_3 + \&c.\right)\right\}$$

$$+ \tfrac{1}{3}gr^2 - \tfrac{1}{2}gr^2(\cos^2\theta - \tfrac{1}{3}),$$

C being an arbitrary constant.

But r, the radius of the surface of the fluid, $= a(1 + ay)$, and by hypothesis $a - a_1$, $a_1 - a_2$, are small quantities; hence, if r be developed, and all small quantities of the second order be neglected, we shall have, remembering that C is arbitrary,

$$C = \frac{4\pi a^2}{3}\left(1 + \frac{a_1^3}{a^3}(D_1 - 1) + \frac{a_2^3}{a^3}(D - D_1)\right) + \tfrac{1}{3}ga^2,$$

and

$$+ \frac{4\pi Da^2 a}{3}y - 4\pi\{aa^2(\tfrac{1}{5}Y_2 + \tfrac{1}{7}Y_3 + \&c.)$$

$$+ a_1 a_1^2(D_1 - 1)(\tfrac{1}{5}U_2 + \tfrac{1}{7}U_3 + \&c.)\}$$

$$+ \tfrac{1}{2}ga^2(\cos^2\theta - \tfrac{1}{3}) = 0.$$

"By a process exactly similar to that performed in the work referred to, and remembering the assumption of the theory, I find for the solid spheroid, $U_3 = 0$, $U_4 = 0$, and in general $U_i = 0$, when i is not 2, and $a_1 U_2 = -e_1(\cos^2\theta - \frac{1}{3})$; e_1 representing the ellipticity of the spheroid. Hence

$$ay = \frac{3aY_2}{5D} + \frac{3a}{D}(\tfrac{1}{7}Y_3 + \&c.)$$

$$- \left(\frac{3(D_1 - 1)}{5D}e_1 + \frac{1}{2}\frac{g}{\frac{4}{3}\pi D}\right)(\cos^2\theta - \tfrac{1}{3}).$$

But also

$$y = Y_2 + Y_3 + Y_4 + \ldots Y_i.$$

Hence, comparing terms of the same order in these expressions, we obtain

$$Y_3 = 0, \quad Y_4 = 0, \ldots \; Y_i = 0,$$

$$a\,Y_2 = \frac{3\,a\,Y_2}{5D} - \left(\frac{3(D_1-1)}{5D}\,e_1 + \tfrac{1}{2}q\right)(\cos^2\theta - \tfrac{1}{3}),$$

or

$$a\,Y_2 = -\Bigl(\frac{6(D_1-1)e_1 + 5qD}{2(5D-3)}\,(\cos^2\theta - \tfrac{1}{3});$$

and, therefore,

$$r = a\left\{1 - \left(\frac{5qD + 6(D_1-1)e_1}{2(5D-3)}\right)(\cos^2\theta - \tfrac{1}{3})\right\}. \qquad \text{(b)}$$

This is an expression for the radius of a spheroidal surface of revolution having the ellipticity

$$\frac{5qD + 6(D_1-1)e_1}{2(5D-3)}.$$

" 3. If the difference between the ellipticities of the spheroid bounding the fluid, and that bounding the solid mass, be represented by ε, we shall have

$$\varepsilon = \frac{5qD - 2(5D - 3D_1)e_1}{2(5D-3)}. \qquad \text{(c)}$$

This expression shows, that when $5D > 3D_1$, ε will decrease when e_1 increases. In the actual case of the earth we should have $D = 2D_1$ nearly, and consequently

$$\varepsilon = \frac{(5q - 7e_1)\,D_1}{(5D-3)}.$$

ε cannot be negative, and if it become zero, $e_1 = \frac{5q}{7}$. But q being the ratio of centrifugal force to gravity at the equator, and, therefore, its value being $\frac{1}{289}$, we should have the ellipticity finally attained by the earth, from the action of superficial causes, equal to $\frac{1}{404.6}$. This quantity is, however, too small to be admissible, and, consequently, the above result alone furnishes a conclusive argument against the theory considered.

" It manifestly follows, from the value which has been found for ε, that if e_1 were small, the waters would tend to accumulate about the equatorial regions; and if, on the contrary, e_1 were large, they would tend to accumulate about the polar regions. If, therefore, from any superficial causes, the earth's figure became gradually more oblate, the extent of polar dry land would gradually tend to lessen, while that of the equatorial regions would at the same time tend to increase. The truth of our fundamental proposition cannot, therefore, admit of any further doubt.

" 4. It may be useful to give still greater force to these conclusions by some additional considerations. With the supposed original spherical figure of the earth, the circumambient fluid would, as already remarked, assume, by the action of centrifugal force, a spheroidal form. The fluid would thus tend to accumulate towards the equator, and to recede from the poles. Circumpolar continents might thus be formed, with a great equatorial ocean between them. Some of the foregoing expressions will assist in determining the conditions of the existence of such continents.

" Let θ_1 represent the complement of the latitude at the parallel bounding a circumpolar continent on the surface of the primitive sphere, then the area of this continent will be

$$\tfrac{1}{2}\,(1 - \cos\theta_1),$$

the area of the sphere being unity. But at that parallel $r = a_1$, and, therefore,

$$a_1 = a\left(1 - \frac{5qD}{2(5D-3)}\,(\cos^2\theta - \tfrac{1}{3})\right),$$

making $e_1 = 0$ in (b). Hence

$$\cos\theta_1 = \pm\sqrt{\left(\tfrac{1}{3} + \frac{2(a-a_1)\,(5D-3)}{5qDa}\right)}.$$

Let δ represent the present mean depth of the sea; L and W the areas of dry land and water, as determined by observation; then as $a - a_1$ is evidently the mean depth of the fluid covering the sphere supposed at rest,

$$\frac{a - a_1}{\delta} = \frac{W}{L + W}, \text{ or } \delta = (a - a_1)\left(1 + \frac{L}{W}\right),$$

$$\cos\theta_1 = \sqrt{\left(\tfrac{1}{3} + \frac{2\delta(5D - 3)}{5qDa\left(1 + \frac{L}{W}\right)}\right)}.$$

By observation,

$$D = 5.5, \quad q = \frac{1}{289}, \quad \frac{L}{W} = \frac{266}{734}.$$

"If, as is generally supposed, the mean depth of the sea be proportional to the mean height of the land above its surface in the relation of their respective areas, the greatest value which can be attributed to $\frac{\delta}{a}$ would be $\frac{1}{4000}$, or a mile nearly. Then

$$\cos\theta_1 = \sqrt{\left(\tfrac{1}{3} + \frac{24.5 \times 289 \times 734}{27.5 \times 2000000}\right)} = \cdot 654083 \text{ nearly.}$$

In this case, therefore, the area of each circumpolar continent would be a little more than a sixth of the area of the entire surface. If $\frac{\delta}{a} = \frac{1}{566.95}$, or if the mean depth of the ocean were 7.055 miles, no circumpolar continents would exist. All authorities, however, appear to concur in thinking that so great a mean depth cannot be attributed to the ocean, but, on the contrary, that it must be, at most, some small fraction of the earth's ellipticity. It follows that if the earth were originally spherical, two great circumpolar continents, with an intermediate equatorial ocean, should necessarily exist. If, in accordance with the assumptions of the theory, the forces tending to transport water towards the equator were more effective than those tending to transport matter towards the poles, the areas of the circumpolar continents would be continually lessening, and at the same time the entire mass would tend to assume the figure of an oblate spheroid. Hence, if any land should exist at the equatorial regions due to small irregularities in the earth's surface, the ratio of its area to that of the circumpolar land would, up to a certain limit, be continually increasing. This conclusion is confirmed by that at which Playfair has arrived in his Illustrations of the Huttonian Theory,* although we cannot implicitly confide in the accuracy of his numerical results, as he has not exhibited the successive steps of his investigation."

Mr. Donovan read the first part of a paper "On the universal Vitality of Matter, and its Exaltation into animal and vegetable Life."

The opinions of the ancient philosophers on this subject were referred to, and it was shown that the vitality of matter was maintained as a fundamental principle in the most celebrated of the schools of antiquity, and that it has been accredited by many in modern times. The author then explained that he was far from attributing to matter any vitality of the kind possessed by animals or even vegetables; and showed that it is possible to conceive the existence of some of the properties of life in matter, along with a capability of conjunction with others, when circumstances favourable to such a change are present. Examples of this kind were given. He adduced instances in which, by the successive abstraction of properties, vitality of the most exalted character was gradually degraded to the lowest kind of inorganic life. Abstracting from all consideration of an immortal spirit which belongs to man alone, it was shown that life and death are merely relative; that many properties of life are discoverable in death; that life may be simulated by death, and death by life; and processes were referred to, in which matter generally considered inanimate assumes additional properties and becomes alive. Many arguments were then brought forward to show that organic life is the result of exalting inorganic life by combination of elementary properties.

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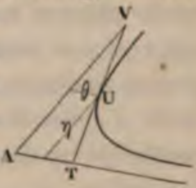
* Works, vol. i. p. 489.

The following extract of a letter from Sir William Rowan Hamilton to the Rev. Charles Graves was read to the Academy:

"If I had been more at leisure when last writing, I should have remarked that besides the construction of the ellipsoid by the two *sliding spheres*, which, in fact, led me last summer to an equation nearly the same as that lately submitted to the Academy, a simple interpretation may be given to the equation,



$$\mathrm{TV}\,\frac{\eta\rho-\rho\theta}{\mathrm{U}\,(\eta-\theta)}=\theta^2-\eta^2; \qquad (1)$$

which may also be thus written,

$$\mathrm{TV}\frac{\rho\eta-\theta\rho}{\eta-\theta}=\frac{\theta^2-\eta^2}{\mathrm{T}\,(\eta-\theta)}. \qquad (2)$$

"At an umbilic U, draw a tangent TUV to the focal hyperbola, meeting the asymptotes in T and V; then I can shew *geometrically*, as also in other ways,—what, indeed, is likely enough to be known,—that the sides of the triangle TAV are, as respects their *lengths*,

$$\overline{\mathrm{AV}}=a+c;\ \overline{\mathrm{AT}}=a-c;\ \overline{\mathrm{TV}}=2b. \qquad (3)$$

Now my η and θ are precisely the halves of the sides AV and AT of this triangle; or they are the two co-ordinates of the umbilic U, referred to the two asymptotes, when *directions* as well as lengths are attended to. This explains several of my formulæ, and accounts for the remarkable circumstance that we can pass to a *confocal surface*, by changing η and θ to $t^{-1}\eta$ and $t\theta$ respectively, where t is a scalar.

"Again we have, identically,

$$\mathrm{V}\frac{\rho\eta-\theta\rho}{\eta-\theta}=\rho_1+\rho_2; \tag{4}$$

if for conciseness we write

$$\rho_1=(\eta-\theta)^{-1}\,\mathrm{S}\,.\,(\eta-\theta)\rho; \tag{5}$$

$$\rho_2=\mathrm{V}\,.\,(\eta-\theta)^{-1}\,\mathrm{V}\,.\,(\eta+\theta)\rho. \tag{6}$$

But ρ_1 is the perpendicular from the centre A of the ellipsoid on the plane of a circular section, through the extremity of any vector or semidiameter ρ; and ρ_2 may be shewn (by a process similar to that which I used to express Mac Cullagh's mode of generation) to be a radius of that circular section, multiplied by the scalar coefficient $\mathrm{S}\,.\,(\eta-\theta)^{-1}\,(\eta+\theta)$, which is equal to

$$\frac{\theta^2-\eta^2}{-(\eta-\theta)^2}=\frac{\mathrm{T}\eta^2-\mathrm{T}\theta^2}{\mathrm{T}\,(\eta-\theta)^2}=\frac{ac}{b^2}. \tag{7}$$

If, then, from the foot of the perpendicular let fall, as above, on the plane of a circular section, we draw a right line in that plane, which bears to the radius of that section the constant ratio of the rectangle (ac) under the two extreme semiaxes to the square (b^2) of the mean semiaxis of the ellipsoid, the equation (2) expresses that the line so drawn will terminate on a spheric surface, which has its centre at the centre of the ellipsoid, and has its radius $=\frac{ac}{b}$; this last being the value of the second member of that equation (2). And, in fact, it is not difficult to prove *geometrically* that this construction conducts to this spheric locus, namely, to the sphere concentric with the ellipsoid, which touches at once the four umbilicar tangent planes."

The Rev. Charles Graves communicated the following theorems relating to the principal circular sections of a central surface of the second order, and the sphero-conics traced upon it.

In a central surface of the second order, the arc of a principal section P, *included between the two principal circular sections* C, C′, *is bisected at the point* t, *where it touches a sphero-conic of the surface.*

The proof of this theorem is extremely simple. The semidiameter drawn to the point t is obviously a semiaxis of the section P; and the semidiameters drawn to the points c and c', in which P meets C and C', are equal to one another, being each equal to the mean semiaxis of the surface; consequently the arc cc' is bisected at t. Precisely in the same manner it might be shown that

The arc of a diametral section, included within one of the sphero-conics of the surface, is bisected at the point where it touches a second sphero-conic of the same system.

From the theorem first stated we deduce the following: *The sector of the surface included between the two principal planes of circular section, and any diametral plane which touches a fixed sphero-conic, is of constant volume.*

For, if we draw a second diametral plane P', infinitely near to P, and touching the same sphero-conic, the two elementary sectors respectively included between P, P', and each of the two principal planes of circular section, will evidently be equal: and for this same reason

The sector included between a cone generated by a semidiameter moving along one of the sphero-conics of the surface, and any diametral plane which touches a fixed sphero-conic, is of constant volume.

May 14th, 1849.

GEORGE PETRIE, LL.D., in the Chair.

William Fraser, Esq., and William Hill Luscombe, Esq., were elected Members of the Academy.

Mr. Petrie read the following list of coins, recently found in the Three-Rock Mountain, near Dublin:

	HENRY VIII.
10	Threepences, struck at Dublin.
2	Do. struck at Bristol.
1	Do. struck at Canterbury.
1	Three-halfpenny piece, struck at Dublin.
32	Sixpences, full face, base, struck at Dublin.
15	Do. do. do. struck at Bristol.
4	Do. do. do. struck at York.
2	Do. do. do. struck at London.
3	Do. *Posui Deum*, Tower Mint.
14	Do. Irish, of his thirteenth year.
24	Harp groats, mostly base.
	EDWARD VI.
2	Shillings, base, side face.
	MARY I.
1	Shilling, silver, Irish.
3	Groats, do. do.
	PHILIP AND MARY.
13	Shillings, base, Irish, 1555.
10	Groats, do. do. 1555.
8	Do. do. do. 1556.
2	Do. do. do. 1557.
5	Do. do. do. date defaced.
45	Rose Pennies, London mint.
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Mr. M. Donovan continued the reading of his paper on the Universal Vitality of Matter, &c.

May 28th, 1849.

REV. HUMPHREY LLOYD, D. D., President, in the Chair.

Dr. A. Smith laid before the Academy a manuscript catalogue of the Tradesmens' Tokens current in Ireland in the seventeenth century, and made a few observations on their use, as illustrating family history and other matters of local interest.

He stated that his object at present was, that the list should be printed in the Proceedings, with the view of circulating it extensively, and thereby inviting the collectors of coins throughout the country to communicate to him notices of such tokens as have not come under his observation, so as to enable him, at some future time, to publish a historical and descriptive catalogue, accompanied with engravings of such of the coins as are peculiar for their devices, or calculated to assist the local historian in his inquiries. (See Appendix, No. IV.)

Professor Davy brought under the consideration of the Academy, a new and simple method he had discovered of detecting manganese in inorganic and organic bodies, as in rocks, minerals, ores, soils, and in vegetable and animal substances, and also of obtaining the salts of manganese in a pure state.

The method consists in mixing the substance to be examined with a little flowers of sulphur, and heating the mixture to a temperature at, or even lower than that of redness, when, if manganese be present, a protosulphate will be formed, the sulphur being acidified, partly at the expense of the oxide, and partly by the oxygen of the air. The sulphate of manganese may be readily dissolved in pure water, and will yield a white prussiate of manganese with a solution of prussiate of potash. These experiments may be made on a very minute scale, where the object is merely to ascertain the presence of manganese, as in ores of iron, soils, &c.; when a slip of platina foil, glass, or porcelain, &c., may be used. Where, however, it may be desirable to obtain the pure salts from the sulphate of manganese, larger quantities of the common oxide of manganese must, of course, be employed. The presence of iron in the common oxide will not interfere with the results, unless under extraordinary circumstances. By this method the author has discovered manganese in a large number of iron ores, as the clay iron ores from Arigna, Merthyr Tydvil, America; the Elba iron ores and specular ores from other localities; the magnetic iron ores from Arendahl, Norway; also in the chromates of iron from North America and the Shetland Islands, kindly furnished by Dr. Scouler. In several of these ores, manganese, it is believed, had not previously been detected.

The Professor has also detected manganese in a number of soils, as in those from the counties of Cork and Kilkenny, and from near Dungannon.

The use of the sulphate of manganese is gradually extending. Already it affords a beautiful brown colour in dyeing and calico printing, and more recently it has been used in medicine as an emetic; and by no known method can it be so readily obtained, in such a pure state, as by the use of manganese and sulphur.

The fine brown durable pigment of manganese, alike applicable, it is believed, to the commonest purposes and the highest works of art, may also be readily procured by the method recommended.

Professor Davy noticed an experiment he had made, which seems to prove the delicacy of the test. He mixed Saxon manganese, sulphur, and fine siliceous sand, in the proportions, by weight, of 1 of manganese, 100 of sulphur, 1000 of sand; and on exposing ten grains of the mixed substances to a red heat on a slip of platina, the mixture afforded, with pure water, a solution of sulphate of manganese, which was rendered turbid by prussiate of potash. The method is applicable to organic substances, both vegetable and animal; but the Professor's experiments on such bodies are still in progress.

The Rev. Charles Graves communicated a general theorem in the Calculus of Quaternions:

Let Q be a variable quaternion, of which $f(Q)$ is a homogeneous function of the n^{th} degree; and let

$$S.df(Q) = S.NdQ,$$

then we shall have

$$S.NQ = nSf(Q). \qquad (1)$$

And, more generally, if Q, Q', Q'', &c., be any number of variable quaternions, of which $f(Q, Q', Q'', \ldots.)$ is a homogeneous function of the n^{th} degree; and if

$$S.df(Q, Q', Q'', \ldots) = S.NdQ + S.N'dQ' + S.N''dQ'' + \&c.,$$

we shall have

$$S.NQ + S.N'Q' + S.N''Q'' + \ldots = nS.f(Q, Q', Q'', \ldots) \quad (2)$$

Let us first establish the theorem in a particular case, and it will afterwards be easy to show that the proof admits of extension to the most general one. Suppose, therefore, that

$$f(Q) = RQR'QR''$$

where R, R', R'' are any constant quaternions; then

$$S.df(Q) = S.RdQR'QR'' + S.RQR'dQR'';$$

or, in virtue of the rule which permits us to execute a cyclic permutation on factors under the *scalar* sign,

$$
\begin{aligned}
S.df(Q) &= S.(R'QR''R + R''RQR')\,dQ \\
&= S.NdQ.
\end{aligned}
$$

Retracing the steps of this process, we see that

$$
\begin{aligned}
S.NQ &= S.(R'QR''R + R''RQR')\,Q \\
&= S.RQR'QR'' + S.RQR'QR'' \\
&= 2S.f(Q).
\end{aligned}
$$

And the proof would hold equally good if $f(Q)$ became the sum of any number of terms, all of the same form as $RQR'QR''$. The theorem is therefore proved for the most general homogeneous function of the second degree of Q. The nature of the proof remaining quite unaltered when we suppose n to become any other positive integer; and, moreover, conceive the function f to depend upon any number of variables, it seems unnecessary to occupy space with the fuller statement of it.

The equation (1) is an extension to the calculus of quaternions of the ordinary algebraic equation,

$$x\frac{d}{dx}x^n = nx^n;$$

and equation (2) is an extension of the more general theorem discovered by Fontaine, viz., that if U be a homogeneous function of the n^{th} degree of any number of variables, x, y, z, &c.,

$$x\frac{dU}{dx} + y\frac{dU}{dy} + z\frac{dU}{dz} + \ldots = nU.$$

By means of this latter theorem it is proved that if a surface be represented by an equation $U = \text{const.}$, in which U is homogeneous, and of the n^{th} degree, in x, y, and z, the equation of its tangent plane at the point xyz will be

$$\frac{dU}{dx}x' + \frac{dU}{dy}y' + \frac{dU}{dz}z' = n\,\text{const.}$$

It was from observing the existence of a similar relation between the equations of a surface of the second order and of its tangent plane, as found by Sir William R. Hamilton in his geometrical applications of the Calculus of Quaternions, that Mr. Graves was led to investigate the theorem now communicated to the Academy.

The following theorem respecting ellipsoids, obtained by the method of quaternions, was communicated by Sir William Rowan Hamilton, in a note to the Secretary of Council:

" On the mean axis of a given ellipsoid, as the major axis, describe an ellipsoid of revolution, of which the equatorial circle shall be touched by those tangents to the principal section of the given ellipsoid (in the plane of the focal hyperbola), which are parallel to the umbilicar diameters. In this equatorial circle, and in every smaller and parallel circle of the new ellipsoid thus constructed, conceive that indefinitely many quadrilaterals are inscribed, for each of which one pair of opposite sides shall be parallel to the given umbilicar diameters, while the other pair of opposite sides shall be parallel to the asymptotes of the focal hyperbola. Then *the intersection of the first pair of opposite sides of the inscribed quadrilateral will be a point on the surface of the given ellipsoid.*

" I may remark that the distance of either focus of the new ellipsoid from the common centre of the new and old ellipsoids, will be equal to the perpendicular let fall from either of the two points, which were called T and V in a recent note and diagram, on the umbilicar semidiameter AU, or on that semidiameter prolonged; while the distance of the umbilic U from the foot of either of these two perpendiculars, that is, the projection of either of the two equal tangents to the focal hyperbola, TU, UV, on the umbilicar semidiameter AU, or on that semidiameter prolonged, will be the minor semiaxis, or the radius of the equator, of the new ellipsoid (of revolution).

"This new ellipsoid *touches* the old one at the ends of the given mean axis; but it also *cuts* the same old or given ellipsoid, in a system of two ellipses, contained in planes perpendicular to the asymptotes of the focal hyperbola.

"If the semiaxes of the given ellipsoid be a, b, c, the common distance of the two *foci* of the new or derived ellipsoid (of revolution) from the common centre of the two ellipsoids, is expressed by the formula

$$e = \frac{\sqrt{(a^2 - b^2)}\ \sqrt{(b^2 - c^2)}}{\sqrt{(a^2 - b^2 + c^2)}}. \tag{1}$$

"And I venture, although with diffidence, to propose the name of the TWO MEDIAL FOCI, for the two points thus determined on the mean axis $2b$ of the ellipsoid a, b, c. If their vectors be denoted by $\pm\,\epsilon$, the equation of that original ellipsoid may be thus written:

$$\mathrm{T}(\lambda_1 + \epsilon) + \mathrm{T}(\lambda_1 - \epsilon) = 2b; \tag{2}$$

or thus,

$$\mathrm{T}(\lambda_1 - \epsilon) = b + b^{-1}\,\mathrm{S}\,.\,\epsilon\lambda_1; \tag{3}$$

where

$$\lambda_1 = \frac{\rho\eta - \theta\rho}{\eta + \theta}; \quad \epsilon = \frac{2\mathrm{V}\,.\,\eta\theta}{\mathrm{T}(\eta + \theta)}; \tag{4}$$

η, θ, ρ, having the same significations as in notes recently read; while e may perhaps be called the MEDIAL EXCENTRICITY of the ellipsoid abc.

"In a future communication I may be induced to return on the quaternion analysis employed, and to submit to the Academy some account of it."

Mr. M. Donovan concluded his paper on the Universal Vitality of Matter.

He remarked, that the title of his paper on the Universal Vitality of Matter had led some persons to imagine that he believed every kind of matter to be endued with life, understood in the common acceptation of the word, than which nothing could be more ridiculous, or farther from his views, which he explained as follows:

"I have shown that there are various kinds or degrees of life; such as that of a man in full possession of health and faculties; of a man who neither sees, hears, feels, tastes, breathes, nor circulates blood, yet is alive and recovers his powers; of a body recently *dead*, as is the expression, in which certain secretions take place, and which is still susceptible of certain stimuli. I have referred to the vitality, in some cases persistent, of an amputated limb; to the retention of life, for a short time, in the decollated heads of men and other animals, in their headless trunks, in small portions of their flesh when removed, in their detached hearts, and in their blood. I have instanced the symptoms of life in vegetables, and also of a peculiar life in some organic beings of so feeble a nature that for ages it had been uncertain whether they were animals or vegetables, and the vital principle was never proved to exist in them. Life is then a quality which assumes almost as many varieties, degrees, and modes as there are classes and states of animals or vegetables.

"I have suggested that it were contrary to the order of nature to suppose that life is utterly extinguished at the point usually called inanimate; that Nature's works glide from one form to another by imperceptible gradations; that it would be a striking anomaly if the general analogy of her proceedings were departed from in this instance, and if there were nothing intermediate to fill up the vast chasm supposed to exist between life and actual exanimation. I have endeavoured to render it probable that there is a grade of life, not recognizable to our senses, and beneath that of the meanest vegetable, which may be exalted by natural processes to the highest degree of intellectual vitality. This low grade is what I call the vitality of matter.

"But, beside all considerations of analogy and probability, I have adduced the testimony of Scripture to prove that the

Almighty infixed vitality in matter along with its other properties: for the command given to all created things, vegetable and animal,* to increase and multiply, must have been accompanied by the endowment of matter with the means of obeying the mandate, namely, with the vital principle. As matter could not become alive of its own accord, the vital principle must have been either infixed in it as an universal and permanent property, or it must be infused into it in each individual case of vivification by divine power. But God must have intended that the command to increase and multiply should be carried into effect without his further interposition in each particular instance ; for if this were not intended there would have been no occasion for the general order given to organized beings to multiply. There must be something congenial to the human mind in the idea that life is one of the elements of which matter is composed ; it has been shown that it was a principle in the philosophy of the ancient Egyptians, of the Pythagoreans, the Peripatetics, the Stoics, the Platonists, the Pantheists, the Hylozoists, and the Magi. It was an accredited opinion of many eminent moderns, as Kepler, Hunter, and Coleridge; and it is still entertained by Bremser and a host of others.

" This view of the subject advances us one step towards the explanation of the phenomena of vivification; for it is more easy to comprehend the intension and remission of a variable quality than its first creation. If life exist as a property of matter, we can understand that it may be modified in a variety of ways, according to the degree of vitality with which the animal or vegetable is to be endued. The kind of life which I suppose to exist in inorganic matter, and which may be called elementary life, is of the lowest character, more feeble than that of the meanest vegetable existence; it is here conceived to be one of the properties of matter, and to be subject to change or modifications, like the other properties of matter, when chemical affinity is exerted with the result of producing combination. The act of combination always produces more or less alteration of the chief properties of the combining bodies, and therefore it may be presumed that so important a property as vitality does not escape the universal change, and that by a succession of such modifications it may be exalted to any required degree. This happens in some way which art cannot accomplish, but which may be closely imitated during the operation of that kind of chemical affinity which produces voltaic phenomena. The voltaic current possesses so much the character of life that it overpowers the real vital principle in the living, simulates it in the dead, and actually restores it to a body which, to all appearance, had ceased to live, and never would have breathed more.

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* See Gen. i. 11, 20, 24, 28.

"As to the manner in which these exaltations of vitality are brought about, nothing but conjecture can be offered; several modes may be imagined. It is indisputable that there are many kinds of life, as has been already evidenced in the different conditions of animals and vegetables. It has been the chief object of this Essay to render it probable that there is a different and lower grade of vitality, this being a property of all inorganic matter; and the mode of reasoning on this question was, that such an assumption accords best with the phenomena of Nature. When chemical action occasions new combinations, a change in the vital state of the matter concerned may take place amongst the alterations of properties which always occur in these cases; and the subject of the new combinations may pass into one or other of the states just mentioned.

"This view is taken under the assumption that life in different instances is different in kind; but an explanation may be conceived, under the supposition that it differs in degree, the kind remaining the same throughout, in which case the differences of vitality induced by chemical combination would amount to mere differences in intensity.

"A third mode of conceiving the change of character which the vital principle may undergo in consequence of chemical combination may be the following. It may be supposed that the vital principle, in its most exalted form, is not simple or uncompounded, but combines in itself the attributes which belong to human vitality, to the vitality of the lower animals, and to that of vegetables. Remove the attributes of man, and the vital principle is degraded to that of the inferior animals; withdraw also the attributes of the inferior animals, and the vital principle becomes elementary; it is reduced to that lowest degree which is a mere property of matter. But matter is peculiarly adapted to recover its lost attributes, when other kinds of matter, possessed of these attributes, enter into combination with it.

"This, of course, is all hypothesis; but it is certain that there are different kinds of life, that one kind may be made to pass into another, and that any of the foregoing assumptions may be employed in explaining such conversions: the facts are quite independent of modes of explanation.

"The transition from what is generally considered total lifelessness to the vital state is in some cases so easy that there is reason to believe the two conditions to be less opposed or remote from each other than is generally supposed. It has been shown that some creatures, to all appearance lifeless, may be brought to life by wetting them; yet, in some instances, they had been for twenty-seven years dead in the common sense of the word, and would have for ever remained so. Others had been killed by immersion in alcohol several times in the space of a few hours, and revivified each time. Vegetable substances afford similar examples of facility of resuscitation, after 1000 or even 3000 years of total quiescence of vitality. To explain these phenomena by pronouncing them cases of suspended animation were to disguise a plain fact by a metaphor. Is it meant that the onion was in a swoon for 3000 years, and that the creature dried up and withered for twenty-seven years, had been dead and alive at the same time? Unless this be the meaning I cannot conceive any other.

" That one kind of life may be made to pass into another, was shown by tracing the progress of vivification of food, from the period of its being taken into the stomach, to that of its constituting part of the animal's body.

" Facts were adduced in support of the argument that by chemical combination vitality is developed in the combining particles; and in proof that the vitality of these particles belongs to them, and not to a common stock contained in the body of the animal, it was shown that parts of the animal body may be removed, yet still retain their vitality; that they may even be replaced, and continue to live; nay, that they may live and grow on the body of some other animal.

" The chief principle involved in these speculations is no doubt an hypothesis. But an hypothesis, in the absence of an adequate induction, may be tolerated in physics, when it agrees with the phenomena, and connects, in one uniform system, a series of propositions which, without it, would remain insulated. Under such circumstances an hypothesis has its chance of being a truth, and is not to be utterly, in all cases, contemned, notwithstanding the denunciation of Newton: hypotheses have rendered good service in some departments of physics."

June 11.

REV. HUMPHREY LLOYD, D. D., President, in the Chair.

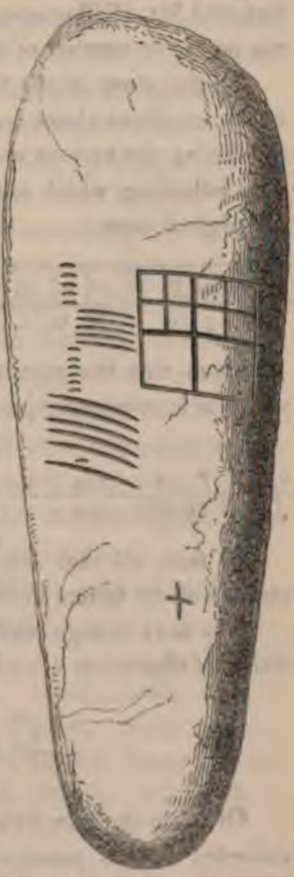
Sir Robert Kane read a paper on the Manufacture of Iron in this country, and exhibited specimens found in different localities.

The Rev. Charles Graves read the Second Part of a Paper on the Ogham Character.

In the former part of this Paper a general account was given of the monuments on which inscriptions in the Ogham character occur; and from the nature both of the monuments themselves, and of the inscriptions which they bear, it was argued that the theory of those antiquaries who refer them to a period anterior to the introduction of Christianity into Ireland is not only unsupported, but is even contradicted by facts.

The great majority of these monuments are characterized by circumstances which more or less distinctly mark them as belonging to the Christian period. Several of them are inscribed with crosses, of a very ancient form, and to all appearance as old as the Ogham inscriptions on them. Many stand in Christian cemeteries; others in the neighbourhood of cells or oratories. Some are still called after ancient saints, though the inscriptions on them do not exhibit the names by which these saints were ordinarily known. Again, some of the inscriptions prove, beyond all doubt, that the persons whose work they are were acquainted with the Latin language. Like some of the very ancient sepulchral monuments of Wales and Cornwall, the Ogham stones, in general, bear either a single proper name in the genitive case, or the proper name accompanied by the patronymic; the names themselves being such as meet us continually in documents relating to the early history of the Christian Church in Ireland.

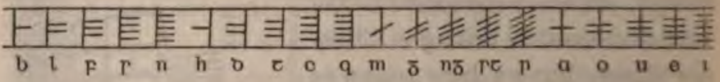
If this question respecting the age of our Ogham monuments could be settled by a single instance, there is a stone in the churchyard of Kinard, in the county of Kerry, which might be referred to as furnishing decisive evidence. This monument is inscribed with a cross, and the name MARIANI written in the Ogham character; and there are no grounds for pretending that it is less ancient than any other Ogham monument in existence. Now, not only does this name, MARIANUS, which is equivalent to the Irish *Maolmaireo*, belong to Christian times, but we have reason to suspect it to be as late as the tenth or eleventh century.



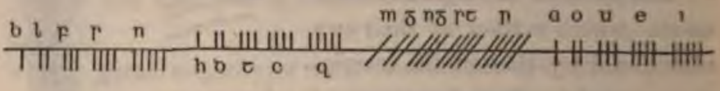
But as there are Ogham monuments, which neither by their own nature, nor by that of the inscriptions upon them, furnish us with any means of directly estimating their antiquity; and as, moreover, it is alleged that the Ogham alphabet and character, having been invented in the most remote Pagan times, continued in use after the introduction of Christianity into this country; it becomes necessary to analyse the structure of this alphabet itself, in order to obtain materials for estimating the time and manner of its formation.

The following brief account of the Ogham alphabet is taken from the tract on Oghams in the Book of Ballymote, and from the Uraicept, an ancient Irish grammatical treatise, of which several copies are extant. It is the more necessary, as errors have crept into the statements which all the most distinguished Irish antiquaries have made respecting the Ogham. O'Flaherty, Molloy, M‘Curtin, Harris, Ledwich, and O'Connor, not to mention General Vallancey, Mr. Beaufort, and Mr. O'Flanagan, have fallen into mistakes as regards the power or number of the letters.

At the close of the Ogham tract in the Book of Ballymote are given about eighty different forms of the alphabet, exhibiting the various modifications to which it was subjected. The following, which is the *first* given, appears to have been its original form :

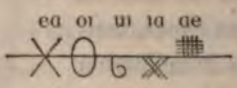


From this the transition was an easy one to the form in which it is commonly presented, viz.:



In fact, all that was necessary was to make the stem-strokes of the letters in the primitive alphabet continuous.

The next change made seems to have consisted in the addition of characters denoting diphthongs :



Of these the two which stand for ea and oi, as may be collected from a passage in the Uraicept, were first added. The three latter appear to have been occasionally employed in other ways. Thus the symbol for u was made to stand for *y*. The symbol for ia is said to have been also used for *p*; and we are told that the symbol for ae denoted likewise *x*, cc, ch, ach, and uch.

It is deserving of notice that, of the diphthongs, none but the first has been as yet found on ancient monuments.

Some modern writers state that *p* was denoted in Ogham by a short stroke parallel to the stem-line. This, however, seems to have been a recent contrivance, resorted to by persons ignorant of the manner in which that letter was represented by those who used the Ogham in ancient times. The proper mode of writing *p* was by bh; and the Uraicept assigns a reason for this practice, viz. that *p* is an aspirated *b*.

We are also presented with a spiral character, said to denote *z*. This too is a modern invention, growing, like the one just mentioned, out of ignorance. The ancient Irish, when they had occasion to write words containing the letter *z*, substituted st or sd for it. Thus in the *Liber Hymnorum* we find the names Elizabeth and Zacharias spelled Elistabeth and Stacharias; and in the copy of the Uraicept, in the Book of Lecan, the name of the Greek letter ζ is written steta.

The fourteenth letter of the Ogham alphabet was certainly intended to represent *z*; but the Irish character employed to signify its power being somewhat like that which stands for *y*, it was supposed to denote that letter. Others, again, have taken it for *x*, contrary to all ancient authority.

The inventors of the Ogham alphabet gave to its letters the names of trees or plants, as follows:

b,	beith,	birch.	m,	muin,	vine.
l,	luis,	quicken.	g,	gort,	ivy.
f,	fearn,	alder.	ng,	ngedal,	broom or reed.
s,	sail,	sallow.	st or *z*,	straif,	blackthorn.
n,	nín,	ash.	r,	ruis,	elder.
h,	huath,	hawthorn.	a,	ailm,	fir.
d,	duir,	oak.	o,	onn,	furze.
t,	tinne,	holly?	u,	ur,	heath.
c,	coll,	hazle.	e,	eaḋaḋ,	aspen.
q or cu,	queirt,	apple.	i,	iḋaḋ,	yew.

ea,	eaḃaḋ,	aspen.
oı,	oıꞃ,	spindletree.
uı,	uılleann,	woodbine.
ıa,	ıꝼın,	gooseberry.

ae, amhancoll, twin coll: as it is formed of two *colls*, *c*'s, or sets of four parallel strokes, laid one across the other.

The Ogham, like the Greek Alphabet, is called *Bethluisnin*, or *Bethluis*, from its first two letters. The former name seems to have given rise to the assertion, that in one form of the ancient Irish alphabet the letter *n* stood third. There is nothing in the Uraicept to countenance this statement; on the other hand, there are passages in it which show that the word nın was occasionally taken in a general signification, and was used with reference to all the letters of the alphabet indifferently.

The letters of the Bethluisnin are all called *trees* (ꝼeaḋa); but that name is applied in a special signification to the vowels, as being trees in the most proper sense. The consonants are termed *side-trees* (ꞇaoḃomna); and the diphthongs *over-trees* (ꝼoꞃꝼeaḋa). The continuous stem-line along which the Ogham letters are ranged is termed the *ridge* (ḋꞃuım); each short stroke, perpendicular or oblique to it, is called a *twig* (ꝼleaꞅᵹ).

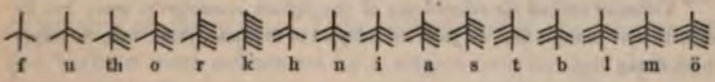
The formation of the Ogham characters indicates a division of the alphabet into groups, each containing five letters. Each group is named after its first letter. Thus the letters *b*, *l*, *f*, *s*, *n* form the *b* group (aıcme b); *h*, *d*, *t*, *c*, *q*, the *h* group (aıcme h); and so on. The diphthongs (ꝼoꞃꝼeḋa) form a group named the ꝼoꞃaıcme.

One of the first things to be remarked in this Ogham alphabet is the separation of the letters into consonants and vowels. This arrangement alone ought to have satisfied any scholar that it was the work of a grammarian, and not a genuine primitive alphabet. Again, the vowels are arranged according to the method of the Irish grammarians, who have divided them into two classes, broad and slender. The broad, ɑ, o, u, are put first; the slender, e, ı, last. At whatever time this distinction had its rise, it was not by any means strictly observed by the earliest writers of this country. Frequent violations of it are to be found in the orthography of the Irish passages in the Book of Armagh, and of the names which occur in the most ancient inscriptions.

There is scarcely any particular in the foregoing account of the Ogham alphabet which does not indicate a connexion between it and the Runic alphabets, especially the later and more developed ones, such as were used by the Anglo-Saxons, and were constructed by persons acquainted with the Roman letters.

The most ancient Runic alphabet was commonly divided into three groups of letters (ätter); thus, *f, u, th, o, r, k*—*h, n, i, a, s*—*t, b, l, m, ö*; and there existed an almost infinite variety of cryptic alphabets, all founded upon this one principle, that the symbol for any letter indicated, in the first instance, to which of these three groups it belonged, and, in the next, the place which it held in that group.

No better instance can be given than the following alphabet, described by Liljegren in his Runlära, p. 50:



Here we see not only an exemplification of the principle on which the Ogham alphabet is constructed, but even a development of it in a form very nearly the same as that of the Ogham itself. Goransson, in his Bautil, p. 232, gives a figure of an ancient monument, on which occur a few words written in these Ogham-like Runes, the remaining part of the inscription being in Runes of the common form.

Other Runic alphabets were formed by repeating the initial letter of each group a different number of times, to denote each of the remaining letters in that group. Thus the symbol for *f*, written thrice, stood for *th;* two *h*'s for *n;* and so on. Here again we have an instance of the use of the principle on which the Ogham alphabet was framed.

It seems extremely probable that the *forms* of the letters in the Runic alphabet, figured above, and in the original Ogham alphabet, suggested the notion of naming the letters of the latter after trees. The Ogham vowels, which have twigs (ꝼleaꞃᵹa) on both sides, are termed simply *trees;* the consonants, which have branches only on one side, or branches placed obliquely, are called *side-trees.*[*]

The idea of a stem-line as a rule or guide to the rest of the characters seems to have been borrowed from the Runes. Goransson furnishes us with several instances of Runes standing on, or depending from, a single straight line. It was also not unusual to make a vertical straight line the common stem-line (staf) to a number of Runes, whose characteristic strokes (kännestrecken) branched out from it consecutively.

The letters *a* and *o* are denoted by the same characters in the oldest Swedish Runic alphabet and in the original Ogham. This circumstance may help us to account for the formation of the vowel group in the Ogham alphabet. Beginning with the vowels *a* and *o*, for which he found Runic characters already formed, viz., stem-strokes, with one or two strokes across, the alphabet maker went on to invent characters for the remaining vowels, on the same principle.

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[*] Vallancey noticed the resemblance of the Ogham characters to trees; but he seems to have thought that the *form* was adapted to the name, rather than the name to the form:

"From the Book of Oghams, translated and published in my Vindication, it appears that the first Ogham characters were intended to represent trees; thus, †: which is exactly the Chinese *key*, or character for a tree, except the additional oblique strokes, 木."—*Prospectus of a Dictionary of the Language of the ancient Irish, Introd.*, p. 34.

It ought also to be mentioned, that an Arabic collection of alphabets, by Ibn Wahshih, translated by Von Hammer, contains two tree-shaped alphabets; of which one is constructed on precisely the same principle as the Ogham. This work, which for a time imposed upon the half learned, is now proved to be of no authority. The greater number of the alphabets which it contains are merely fictitious; and its pretended explanations of Egyptian hieroglyphics are all found to be incorrect.

So much for the tree-form of the Ogham letters. Their tree-names seem to have multiplied in somewhat a similar manner. In the original Runic alphabet but two of the letters are named after trees: thorn, and birch. In the later and more developed Anglo-Saxon alphabets we find the number of tree-names increased to six: thorn, yew, sedge, birch, oak, and ash. The contriver of the Ogham alphabet named all his letters after trees. In this case, as in the former one, we see a progress in a certain direction, obviously arising out of a desire to *systematize*.

When we come to consider the powers of the letters in the Ogham, we find fresh reason to infer its close connexion with the Runic alphabet.

The letter h, though excluded from the number of radical letters by modern Irish grammarians,* was manifestly thought indispensable when the Ogham alphabet was framed. We cannot otherwise account for the fact, that a character is assigned to it, the removal of which would entirely disturb the symmetry of the scale. This indicates that the framers of the Ogham were influenced by a regard to a foreign alphabet into which h enters as a radical letter. We find h an element in the oldest Swedish alphabet of sixteen Runes, as well as in the Semitic alphabets, with which some writers have vainly endeavoured to connect the Ogham.

Again, the letter p is wanting, both in the original Ogham and in the oldest Runes. And in the later Runic alphabets it is represented by a dotted *b*. (*Stunginn Biarkan.*) On the other hand, p is a primitive letter in the Phœnician alphabet.[*]

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* O'Donovan's Grammar of the Irish Language, p. 31.

Hickes[†] presents us with two alphabets of Runes, such as he supposes were in use amongst the Anglo-Saxons after the influence of the Danes had been established in England. In these we find a character standing for *q*, and called *cweorth*;[‡] another called *stan*, denoting *st* or *z*; another named *ing*, probably equivalent to *ng*, the thirteenth letter of the Ogham. The diphthongs are placed at the end of both, as in the Ogham.

The division of vowels into the two classes of broad and slender, though it be a really existing and important one,[§] is not noticed, so far as we are aware, by the ancient Greek, Latin, or Arabian grammarians. In the Scandinavian languages it is observed; and rules founded upon it are given in the Danish and Swedish grammars of the present day.

It is vain to assert that the Irish grammarians who used and wrote about the Ogham were unacquainted with the Scandinavian or Anglo-Saxon Runes. We have their own evidence to the contrary. Amongst the Ogham alphabets figured in the Book of Ballymote we find two Runic alphabets tolerably correctly written; one is called Oᵹham na Loochlannach (the Ogham of the men of Lochlan). The other is named Ᵹalloᵹham (the Ogham of the foreigners); and along with it are given the Icelandic names of the letters.

But the most conclusive testimony on this head is furnished by a fragment lately discovered by Mr. Eugene Curry in a MS. in the Library of Trinity College, Dublin. A folio of vellum, used as a fly-leaf to bind together a small fasciculus included in the volume, was found by him to have contained a short poem furnishing rules for the construction of a Runic Ogham, and followed by the alphabet itself written in full. The first five letters of the latter are wanting, and some of the remaining ones are very indistinct. Enough, however, is left to show that it was a fully developed and comparatively recent alphabet of Runes, arranged according to the order of the letters in the Ogham alphabet. The following fac-simile exhibits as much of it as is at all distinct.

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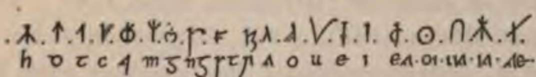
[*] Gesenii Mon. Scrip. et Lit. Phœn., p. 41.

[†] Gram. Anglo-Sax. et Mæsogoth., pp. 135-6.

[‡] Hence, no doubt, the Irish name of *q*, queiꞃꞇ or cueiꞃꞇ, which does not seem to be a genuine Irish word. But what is the origin of *cweorth?* It seems as if it had been formed according to the analogy of *peọrth* (a pawn), the name given to the Anglo-Saxon Rune for *p*.

[§] Latham on the English Language, p. 122.



The beginnings and endings of several of the verses are illegible; but their general purport appears from the parts which remain. They were merely intended to remind a person of the mode in which the several Runes were formed; thus: t *as a hook* [*turned*] *towards you: two fingers up in* c*; *st *two twigs on a twig—two fingers in the back of* o*—two twigs from one root in* u*—&c.*

Fortunately the last line is perfect, and contains the following distinct recognition of the introduction of the Ogham:

Tucad anall a truaill claideim ri Lochland
In togum dar lear asi a laim fein ro dasben.

Hither was brought, in the sword sheath of Lochlan's king,
The Ogham across the sea. It was his own hand that cut it.

If this statement be true, it would appear that the Ogham alphabet of twenty-five letters, simple and compound, arranged in a peculiar order, was introduced into Ireland from some part of Scandinavia or northern Germany. But, wherever it had its origin, the *order* of its letters must have been fixed upon before the tree-shaped characters were invented; and this order, as we have already observed, being founded on the distinction between consonants, vowels, and diphthongs, proves the alphabet not to be a primitive one, but the contrivance of a grammarian.

The assertion that the Runic Ogham, just described, was cut upon the sheath of a sword, is in accordance with what we know of the customs of the Northern people. The hilt of the sword with which Beôwulf slew the Grendel's mother is described as having been marked with Rune staves (BEOWULF, l. 3388); and in the Edda we find Brynhildr teaching Sigurdr to cut the Sigrunar (victorious Runes) on the hilt and other parts of his sword (Brynhildr, Quid. I. 6). The Archæological Album (1845), p. 204, furnishes us with a representation of a silver sword-hilt thus inscribed with Runes, which was found some time ago in Kent.

It is worthy of notice that the most ancient authorities number Ogma, the inventor of the Ogham character, amongst the Tuatha De Danann. Those who believe that race to have been a northern one will regard this circumstance as a confirmation of the theory which connects the Ogham with the Runes. As for the name of Ogma, it seems likely to denote only a mythological personage. He is described as being the grandson of Elaðam (*Scientia*).

Dr. O'Connor, who took most pains to examine the structure of the Ogham alphabet, seems to have felt considerable misgivings as to its antiquity. He distinctly avows his belief that it originally had but sixteen letters; and, in consequence of this supposition, he is forced to admit that the tree-shaped letters (*formas rectilineares*) may be of modern invention. He even expresses a doubt as to the date of the Uraicept, which is the oldest authority on all points relative to Irish grammar. Still he maintains that the Irish possessed a primitive alphabet of sixteen Ogham letters, all named after trees.

All that can be said in reply to this assertion is, that if we deny the antiquity of the Ogham alphabet as it has been handed down to us, we have no proof remaining of the existence of any older Ogham. The monuments, whose antiquity is so much boasted, bear inscriptions in the commonly received Ogham. The most ancient manuscript treatises on grammar describe it, and no other. These being the only evidences which we possess, bearing upon the question before us, if they be set aside, we are abandoned to mere conjecture. The truth is, that nearly all the assertions which have been put forward by Irish antiquaries, respecting the origin and use of letters amongst the ancient Irish, rest upon the authority either of the Tract on Ogham, so often alluded to, or of the Uraicept: and, on this account, an analysis of these treatises ought long since to have been given to the world. When critically examined, they will be found to be compositions of a much later date than is commonly assigned to them; nay, even devoid of peculiar ancient elements which we might suppose to have been wrought up by later writers, interpolating and commenting upon them. The Uraicept, in its present form, cannot have been written before the latter part of the ninth century; and its authors, whoever they may have been, were persons whose notions of grammar were derived from Priscian and Donatus.

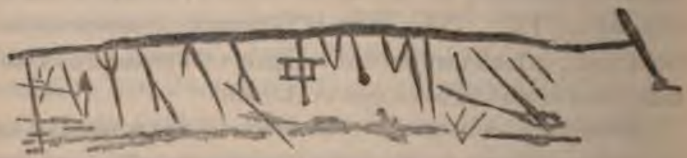
We may, indeed, be reminded that the most ancient Irish tales contain allusions to the use of the Ogham character in remote pagan times. A tale in the Leabhar na hUidhri mentions a monument erected in memory of Fothadh Airgthech, whose death is referred to the third century. The story of Deirdre, published by the Gaelic Society, contains a similar allusion (p. 127). The Book of Ballymote preserves an ancient tract, which mentions the Ogham monument of Fiachrach, who is said to have died A. D. 380.

Before we can estimate the value of this testimony, we must approximate to the date of the composition of these tales. Their evidence will be of little weight if it should appear that they were written long after the erection of existing Ogham monuments, which certainly belong to Christian times.

The conclusion to which Mr. Graves has arrived, as regards the origin of Ogham character, is shortly this, that it was framed by persons acquainted with the later and developed Runic alphabets, such as were used by the Anglo-Saxons. If this conclusion be well founded, the existence of Ogham monuments in Ireland does not prove, as is commonly supposed, that the Irish had the use of letters before the introduction of Christianity into this country. On the other hand, it must be admitted, that even if the recency of the Ogham be granted, the question respecting the time of the introduction of letters into Ireland still remains unsettled. Long before the invention of the Ogham character, it seems likely that the Irish may have had letters of some kind: either Roman letters obtained from Britain, or Runes derived from some of the Northern nations, with whom they certainly had intercourse in very remote times.

Mr. Graves exhibited a rubbing of an inscription on one of the upright stones supporting a cromleach at Lennan in the parish of Tullycorbet, county of Monaghan.

The inscription, though not deeply cut, is well preserved, being executed on a smooth part of the stone, completely sheltered from the action of the weather.



Of its genuineness Mr. Graves acknowledged that doubts might be entertained, inasmuch as no similar inscriptions have been yet discovered in this country. At the same time he thought it desirable to bring it under the notice of antiquaries, in order that, if it be spurious, competent authority may pronounce it to be a forgery; or, if it should appear to be genuine, that other inscriptions of the same kind might be sought for on the cromleachs which abound in this country.

Mr. Graves suggested that some persons in the neighbourhood of Tullycorbet might possibly possess information calculated to throw light on this question.

The characters employed in the inscription seem to be Runes depending from a stem-line; a mode of Runic writing which certainly was in use, though not the commonest. Mr. Graves abstained from offering any conjectures as to the reading of the inscription; hoping that, if it should prove deserving of their attention, some of the English or Northern antiquaries, who have made Runes their special study, might be induced to exercise their deciphering powers upon it.

A note was read from the Rev. Mr. Armstrong, of Kilmuckridge, County Wexford, describing an ancient earthenware urn or crucible, found in his neighbourhood, containing several specimens of bronze articles, such as celts, rings, and a gouge, all in a state of advanced oxidation; and also a portion of an instrument, composed apparently of an alloy resembling speculum metal, which was not oxidated on the surface. The hardness of the composition of this article was so great, a penknife would not cut it.

"The urn was discovered about three feet below the surface, with a flag placed over it; but no other stone, of any size or description, was found near it. The soil in which it was imbedded is a stiff, yellow clay, but the urn was filled with a dark-coloured earth, similar to that of the upper stratum. The urn contained no remains of bone, &c., or any other articles of antiquity than those now in your possession.

"The name of the townland in which the urn was found is Ballyvadden, in the parish of Kilmuckridge; and the name of the finder is Patrick Dempsey.

"I regret that I have not been able to procure more satisfactory information on the subject.

"Over the spot where the urn was found there was a mound of earth, in removing which to fill a marl-pit, and in levelling the bank, the discovery was made; but whether the mound was occasioned by the opening of the marl-pit in the first instance, or existed there previously, does not appear."

Sir William Betham exhibited a seal belonging to Mr. Cooke of Parsonstown, found in the river at Roscrea, bearing the "fleur de lis," with the inscription "S. GALFRIDI CORNUBIENSIS," apparently of the early part of the fourteenth century.

Sir William stated that he had not been able to connect this Geoffrey Cornwall with Ireland by the Irish records, but there could be no doubt it was the seal of Sir Geoffrey Cornwall, Knight, who died about 1342, or his son, Sir Geoffrey, who died about 1364.

The first Sir Geoffrey Cornwall was son of Sir Richard de Cornubia, natural son of Prince Richard Plantagenet, Earl of Cornwall and Poictou, King of the Romans, second son of King John. He married Margaret, daughter and co-heir of Hugh de Mortimer, of Rickard's Castle, and sister of Joan, wife of Richard Talbot, Lord of Rickard's Castle, ancestor to the Earl of Shrewsbury. Sir Geoffrey obtained the barony of Burford with Margaret, and large estates in Shropshire and Herefordshire. He had a grant of free warren in his manors of Stepleton, Dineford, Norton, Auberden, and Nimindon, 10 Edw. II. 1316; and a market and fair at Stepleton, 1333, 8 Edw. III. On his death, about 1342, he was found seised of the manor of Thorpe and half the manor of Norton, in Northamptonshire, with other lands.

His son, Sir Geoffrey de Cornubia (or Cornwall), married Cecilia, daughter of ——— ; and dying about 1364, he was found seised of half the manor of Racheford, and all that of Stepleton, and the lands of Lentwardyn, in Herefordshire; the manors of Burford and Overes hundred in Shropshire, the manor of Ambredene, in Essex; the manor of Thorpe, &c., in Northamptonshire; that of King's Newton, in Devonshire; Boreford, Puttlesden, Wyle, Sockton Stormy, Sheldesley Groat, Achford, Overton, and Hulle, in Shropshire.

His descendant, Sir Thomas Cornwall, was knighted by Edward IV., and Sir Edmond Cornwall was made Knight of the Bath at the coronation of Richard III.

It has not been ascertained that Geoffrey de Cornwall had any connexion with Ireland, as far as the records are concerned, as his name has not been discovered thereon; but the seal being found here, it would indicate that he had possessions in Ireland.

Rev. Charles Graves exhibited, on the part of Mr. Courtney Kenny, a large specimen of Iceland spar, found near Cong, County Mayo.

Rev. Dr. Todd presented to the Museum, on the part of Mr. Edward Graves, a collection of knives, arrow-heads, &c., found in the Island of Sacrificios, on the coast of Mexico. These articles bear a remarkable analogy in their forms to the antiquities composed of flint found in Ireland, and also to those deposited in the Museum of the Academy.

June 25th, 1849.

REV. HUMPHREY LLOYD, D. D., President, in Chair.

Rev. Dr. Todd read a paper by Rev. Dr. Hincks, on Khorsabad Inscriptions, &c.

This paper begins with pointing out the relationship of character used at Khorsabad to those of the other kinds of neatic writings; all of which, with the exception of the Persepolitan, the author considers to be connected toget The Khorsabad characters correspond to the complicated pidary characters in the great inscription at the India Ho in the same manner as it was shown in a former paper that third Persepolitan characters do. They differ, however, most instances, from these; and it requires some attentio the manner in which they are used, and to the words wh are common to the different classes of inscriptions, to av falling occasionally into serious error. The language of these inscriptions is nearly the same, as is proved by the currence of the same words, preformatives, and pronomi affixes in all of them. The Van inscriptions contain ma words found in the Assyrio-Babylonian, but not the pre matives of verbs nor pronominal affixes; on the other ha they have case-endings attached to the nouns, and verbal minations, which characterize an Indo-European langua The second Persepolitan characters resemble the Khorsab ones less closely than the others do; but in the great ma rity of instances the connexion between them can be trac The language of these inscriptions differs decidedly from th of the other classes. Having exhibited specimens of the c responding characters in the several kinds of writing, a explained the system by which he represents in Europe characters their several sounds, he proceeds to illustrate examples the several kinds of ideographs, including determinative signs. The reading of the names of Babylon, Assyria, and Jerusalem, and of the royal names of Nebuchadnezzar the Great, and his father, of Esarchaddon, who built the south-west palace at Nimrud, Sennacherib, who built the palace at Kouyunjik, and his father, who built the palace at Khorsabad, are fully discussed. The author then proceeds to consider the chronological order of the inscriptions. Those which are engraved on the reverses of many of the slabs were cut before the others, and then rejected; the slab being turned, and a new inscription engraved on its other face. This is easily accounted for by supposing that, in the course of his reign, the position of the king was materially altered. Now it appears that on the reverses of the slabs he is not spoken of as being in possession of Babylon; nor is Nebo, the peculiar god of the Babylonians, mentioned among the other gods. In the inscriptions found in front, Nebo is named with high honour, and authority over Babylon is claimed. The builder of the palace does not, however, term himself "king" of Babylon, but uses a different name. The custom of appointing dependent kings is illustrated by various examples, and the conclusion arrived at is, that this king, having conquered Babylon, appointed a dependent king. The date of this conquest is fixed as 731 B. C. when Chinzirus and Porus are said to have commenced their reign. Chinzirus was the Khorsabad king, of whose name it is shown that it is a possible corruption; and Porus was the dependent Assyrian king of Babylon. His name is identified with Pul, that of a former king of Assyria. It is shown that the date of this conquest was subsequent to the tenth year of the reign of Chinnilin, and before his fifteenth, probably about the thirteenth. This would place his accession in 744, which cannot be much astray. His contemporaries were Bocchoris, King of Egypt, and Gita, King of Ethiopia, the reading of which four names is explained. The last is identified with the Zit of Africanus. The Egyptian chronology subsequent to these kings is shown to be consistent with the data de from the canon of Ptolemy; and a comparative view of A rian, Babylonian, Jewish, and Egyptian reigns conclude paper.

Mr. William K. Sullivan read, by permission of the demy, the following notice on the Chemical History of P of Plants.

"The object of the present memoir is merely to brin fore the notice of the Academy a few of the results at wh have arrived in the course of a long series of researches o chemical nature of the pollen of plants. I hope to hav honour of laying before the Academy, at its next meetin November, a detailed account of all the results which I obtained.

"Hitherto I have examined the subject only in two p of view, viz., the proximate analysis, and the action of acid on pollenin.

"If pollen be treated with ether until nothing furth dissolved, and if the ether be distilled off, an oil is obtained ing all the properties of an acid. In all the pollens which I examined I have found this to be the case; in no inst could I detect the presence of glycerine. This is the case with which I am acquanted, in the whole vegetable k dom, of the existence of a free oily acid. The presence o oily acid in pollens has evidently an intimate connexion the office which they perform in vegetation. Fritsche, speaking of the question as to whether the pollen-sac con granules of different chemical compositions, and which of t granules is necessary to the function of fructification, that from his experiments he can only draw the probabl roneous conclusion that the oil-globules exist in every po and that they are necessary for fructification, while the o

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* *Ueber den Pollen*, Petersburgh, 1837, p. 33.

kinds of granules occur very seldom, and are probably only intended to supply material for the formation of the pollenic tubes. This opinion, which is borne out by the researches of most others, coincides singularly with the anomalous chemical nature of the oil-globule itself. If the oil be saponified by carbonate of soda, from which it readily expels the carbonic acid, and precipitated by acetate of lead, and the lead salt treated with pure anhydrous ether, the greater part will dissolve, leaving a quantity of a lead salt, which, on decomposition with hydrochloric acid, yields a solid, white, fat acid, having all the properties of the acid obtained by the saponification of pure bee's wax. At present I prefer not giving any formula for this body. The portion soluble in ether, when decomposed, yields an oil which appears in every respect to be oleic acid. The quantity of the wax varies in different pollens, and it even appears to vary in different specimens of the same pollen. The pollen which I in general employed was that of the *Pinus picea*, but I have also examined that of *Pinus sylvestris*, *Abies excelsa*, *Ulex europeus*, *Sarothamnius scoparius*, and another species, *Crataegus monogyna*, *Sambicus nigra*, *Ilex aquifolium*, *Ranunculus hederaceus*, β *grandiflorus*, and also the sporules of *Lycopodium clavatum*.

"I have not been able to determine whether the stigma of plants is alkaline. I at first believed that such might be the case, and that some connexion existed between the acid nature of the pollen and the alkaline nature, if such be so, of the stigma; but the results at which I have arrived, with reference to the constitution of the pollenine itself, and particularly with reference to the chemical nature of the sporules of lycopodium, lead me to think that the origin of the oil-globules is simply a chemical metamorphosis of the pollenine, as I will point out in another place.

"The residue, after treatment with ether, was boiled for some minutes with a weak solution of potash, and then with pure water. The mass which remained after this treatment consists of the pollenine of Bucholz and John,[*] and is variable in quantity for each plant. From the pollen of *Pinus picea* I obtained about 80 per cent. Herepath obtained from

Lilium bulbiferum, ...	43·012
——— candidum, ...	36·936
Cactus speciosissimus, ...	46·575[†]

"The pollenine obtained from *Pinus picea* scarcely differs in appearance from the original pollen; it is insoluble in every substance which I have hitherto tried; while the pollen of the typha, according to Braconnot, dissolves without decomposition in concentrated acids; and those of *Lilium bulbiferum* and *candidum* have the same property, according to Herepath. The only pollen having this property, which I examined, was that of the holly. I have never been able to detect the slightest trace of starch in pollen, which agrees perfectly with the views of Raspail. Sugar, on the contrary, appears to be always present. On the presence of malic acid, which is stated to have been found in the pollen of the date by Fourcroy, and in that of the cedar by Macaire Prinsep, I cannot decide; at least I have not been able to detect its presence in any of the pollens which I have examined. Sulphur does not appear to be a constant constituent, although I have found it present as sulphate in most of the pollens which I examined, which agrees with the analysis of the pollen of the cedar by Macaire Prinsep.[‡] Phosphorus, on the other hand, appears to play an important part in the function of pollens; I am inclined to think it exists, not only as phosphoric acid, but also as phosphorus in combination with organic matter, in some pollens. The quantity of phosphoric acid yielded by the ash of most pollens exceeds 40 per cent.

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[*] *Annal. des Sciences d'Obs.*, tom. iii. p. 338. 1830.

[†] Quarterly Journal of the Chemical Society, No. i. p. I.

[‡] *Bibliotheque Universelle*, 1830, l. 5.

"Silica appears to be always present, and sometimes in considerable quantity. The proportion of magnesia and of alkalies is also remarkable.

"Whether pollenine is a homogeneous substance, or not, remains yet to be decided. The analyses hitherto made, as well as my own, give very varying results. The difficulty of obtaining sufficient material has hitherto prevented me from endeavouring to effect a separation of the tissues which usually compose the grain of pollen, but I hope in a short time to arrive at some results on this point. I have, however, been able to settle one point, that is, the existence of nitrogen. In every pollen which I have hitherto examined I have found that substance, and generally in very large proportion, in some cases 8 and 9, and in another 11 per cent.

"I have examined the products of the action of nitric acid on the pollenine, and have arrived at some very remarkable results which, when completed, will, I hope, throw considerable light on the nature of that body.

"When pollenine from the pollen of *Pinus picea* is treated with nitric acid of sp. gr. 1·25, in a retort to which is attached an apparatus for condensing, kept extremely cool, and gently heated, a violent action takes place, and after some time the whole of the pollen disappears, the surface of the liquid in the retort becomes covered with a considerable layer of oil. If the distillation be continued for some time, a quantity of oil will distil over, a portion of which will float in the liquid in the receiver, while a considerable portion will be found in solution. The oil which distils over consists principally of butyric, valerianic, and the other volatile acids derived from the action of nitric acid on fats. I have not as yet sufficiently examined the fatty body which forms on the surface of the liquid in the retort. It is perfectly white, soft, and fuses at a very low temperature, forming a perfectly colourless oil having an extremely aromatic smell, and decomposing when strongly heated. By continuing the action of nitric acid upon it, it entirely breaks up into suberic acid, valerianic acid, veleronnitrile, and some other products. During the oxidation of the pollen, abundance of hydrocyanic acid is given off, indeed in such quantity as to mask the smell of every other body. This is an additional proof of the presence of nitrogen.

"When the solid fat is removed from the retort, and the remaining liquid distilled nearly to dryness until all the volatile oily acids have passed over, there remains in the retort a large quantity of suberic acid, and also pimelic, and the other acids obtained in the oxidation of fat, but the principal product is suberic acid. I obtained oxalic acid only from one pollen, namely, *Crataegus monogyna.*

"It would be premature to speak of the nature of the white solid fat, but I may state that I think I will be able to establish its relation to wax on one side, and to lignine and starch on the other.

"There is one point more, of great interest, to which I would beg to call the attention of botanists. Wydeler, as a consequence of the theory of Schleiden, maintains that plants have not two sexes, as hitherto supposed; that the anther, far from being the male organ, is the female,—in fact, an ovary; that the pollen grain is the germ of a new plant; that the pollinic tube becomes the embryo within the embryo sac of the ovule, which merely supplies nourishment and shelter to the embryo up to a certain period; and that this phenomena is improperly termed 'fecundation.'* I think the chemical nature of the pollen of *Lycopodium clavatum*, which is a true germ or sporule, bears out this view in full. I have obtained all the products from that body which I have obtained from the pollen of the *Pinus picea*, &c.

"I hoped to have been able to have arrived at some further conclusions this Spring, but want of time, and the badness of the season, prevented me from obtaining pollen in any quantity; indeed it is not very easy to obtain it at any time. However, I hope to be able to add something more important, particularly with reference to the nature of wax and its connexion with pollen, at the next meeting of the Academy."

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* Wilson in Hooker's Journal, t. xxiv. 92.

The President made a short communication on the relation of the Variations of the Magnetic Elements (diurnal and annual) to the contemporaneous Variations of Temperature.

Having already shown* that the changes of the magnetic declination, and those of temperature, were connected in the most intimate manner, the author was naturally led to expect a similar correspondence in the case of the other magnetic elements. This expectation has been fully confirmed, so far as relates to the intensity of the horizontal component of the magnetic force. Upon a comparison of the results of observation of this element for the four years (1840–1843) already discussed, he has found that the diurnal range of the intensity (or the area of the diurnal curve, which observes a similar law) undergoes a change in the course of the year analogous to that which has been already found in the case of the declination, and, therefore, like it, closely resembling the corresponding variation of the range of temperature. The minimum range of the intensity (like that of the declination and temperature) occurs in December. There are two maxima, with a small intervening minimum; the first of these occurs (as in the case of the declination) in April, and the second in July.

The mean diurnal ranges of the intensity, in the separate years, likewise follow a progression similar to that of the temperature, being greatest in the first of the four years above mentioned, and diminishing thence unto the last.

The *annual variation* of the horizontal intensity is, in like manner, closely connected with the corresponding variation of temperature; and, like it, is represented by a single oscillation. In the mean of the years hitherto examined the minimum occurs, both for the intensity and temperature, in the month of February. The epochs of the maxima do not accord quite so closely, that of the intensity taking place about the beginning of July, while that of the temperature occurs a month later; but as the amount varies very little near the epoch of the maximum, and as there is considerable difference in this respect in the results of different years, we may reasonably expect a closer agreement in the means deduced from a greater number of separate years. The mean amount of the annual variation of the intensity is about ·0014 of the whole.

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* *Results of Observations made at the Magnetical Observatory of Dublin.* (First Series.) Trans. R. I. A., vol. xxii. part i.

The author concluded by some remarks on the bearing of these facts upon the physical explanation of the phenomena.

Sir William Rowan Hamilton communicated to the Academy some results, obtained by the quaternion analysis, respecting the *inscription of gauche polygons in surfaces of the second order.*

If it be required to inscribe a rectilinear polygon P, P_1, $P_2 \ldots P_{n-1}$ in such a surface, under the conditions that its n successive sides, PP_1, P_1P_2, $\ldots P_{n-1}P$, shall pass respectively through n given points, A_1, A_2, $\ldots A_n$, the analysis of Sir W. R. H. conducts to *one*, or to *two real right lines*, as containing the first corner P, according as the number n of sides is *odd* or *even:* while, in the latter of these two cases, the two real right lines thus found are *reciprocal polars* of each other, with reference to the surface in which the polygon is to be inscribed. Thus, for the inscription of a plane triangle, or of a gauche pentagon, heptagon, &c., in a surface of the second order, where three, five, seven, &c. points are given upon its sides, a single right line is found, which may or may not intersect the surface; and the problem of inscription admits generally of two real *or* of two imaginary solutions. But for the inscription of a gauche quadrilateral, hexagon, octagon, &c., when four, six, eight, &c. points are given on its successive sides, two real right lines are found, which (as above stated) are polars of each other; and therefore, if the surface be an ellipsoid, or a hyperboloid of *two* sheets, the problem admits generally of two real *and* of two imaginary solutions: while if the surface be a hyperboloid of *one* sheet, the four solutions are then, in general, together real, or together imaginary.

When a gauche pentagon, or polygon with $2m+1$ sides, is to be inscribed in an ellipsoid or in a double-sheeted hyperboloid, and when the single straight line, found as above, lies wholly outside the surface, so as to give two imaginary solutions of the problem as at first proposed, this line is still not useless geometrically; for its reciprocal polar intersects the surface in two real points, of which each is the first corner of an inscribed decagon, or polygon with $4m+2$ sides, whose $2m+1$ pairs of *opposite sides* intersect each other respectively in the $2m+1$ given points, $A_1, A_2, \ldots A_{2m+1}$. Thus when, in the well known problem of inscribing a triangle in a plane conic, whose sides shall pass through three given points, the known rectilinear locus of the first corner is found to have no real intersection with the conic, so that the problem, as usually viewed, admits of no real solution, and that the inscription of the *triangle* becomes geometrically *impossible;* we have only to conceive an ellipsoid, or a double-sheeted hyperboloid, to be so constructed as to contain the given conic upon its surface; and then to take, with respect to this surface, the polar of this known right line, in order to obtain two *real* or geometrically possible solutions of *another* problem, not less interesting: since this rectilinear polar will cut the surface in two real points, of which each is the first corner of an *inscribed gauche hexagon* whose *opposite sides intersect* each other in the three points proposed. (It may be noticed that the three *diagonals* of this gauche hexagon, or the three right lines joining each corner to the opposite one, intersect each other in *one common point*, namely, in the pole of the given plane).

If we seek to inscribe a polygon of $4m$ sides in a surface of the second order, under the condition that its opposite sides shall intersect respectively in $2m$ given points, the quaternion analysis conducts generally to two polar right lines, as loci of the first corner, which lines are the same with those that would be otherwise found as loci of the first corner of an inscribed polygon of $2m$ sides, passing respectively through the $2m$ given points. Thus, *in general*, the polygon of $4m$ sides, found as above, is merely the polygon of $2m$ sides, with *each side twice traversed* by the motion of a point along its perimeter. But if a certain *condition* be satisfied, by a certain *arrangement of the* $2m$ *given points* in space; namely, if the last point A_{2m} be on that real right line which is the locus of the first corner of a real or imaginary inscribed polygon of $2m-1$ sides, which pass respectively through the first $2m-1$ given points $A_1, \ldots A_{2m-1}$; then the inscribed polygon of $4m$ distinct sides becomes not only possible but *indeterminate*, its first corner being in this case allowed to take *any position on the surface*. For example, if the two triangles $P' P'_1 P'_2$, $P'' P''_1 P''_2$ be inscribed in a conic, so that the corresponding sides $P' P'_1$ and $P'' P''_1$ intersect each other in A_1; $P'_1 P'_2$ and $P''_1 P''_2$ in A_2; and $P'_2 P'$, $P''_2 P''$, in A_3; and if we take a fourth point A_4 on the right line $P' P''$, and conceive any surface of the second order constructed so as to contain the given conic; then *any point* P, on this surface, is fit to be the first corner of a plane or gauche *octagon*, $P P_1 \ldots P_7$, inscribed in the surface, so that the first and fifth sides $P P_1$, $P_4 P_5$ shall intersect in A_1; the second and sixth sides in A_2; the third and seventh sides in A_3; and the fourth and eighth in A_4. And generally if $2m$ given points be points of intersection of opposite sides of *any one* inscribed polygon of $4m$ sides, the *same* $2m$ *points* are then fit to be intersections of opposite sides of *infinitely many other* inscribed polygons, plane or gauche, of

$4m$ sides. A very elementary example is furnished by an inscribed plane quadrilateral, of which the two points of meeting of opposite sides are well known to be *conjugate*, relatively to the conic or to the surface, and are adapted to be the points of meeting of opposite sides of infinitely many other inscribed quadrilaterals.

When *all the sides but one*, of an inscribed gauche polygon, pass through given points, the *remaining side* may be said *generally* to be *doubly tangent* to a real or imaginary *surface of the fourth order*, which separates itself into *two* real or imaginary *surfaces of the second order*, having real or imaginary *double contact* with the original surface of the second order, and with each other. If the original surface be an ellipsoid (E), and if the number of sides of the inscribed polygon, $PP_1 \ldots P_{2m}$, be odd, $= 2m+1$, so that the number of fixed points $A_1, \ldots A_{2m}$ is even, $= 2m$, then the two surfaces enveloped by the last side $P_{2m}P$ are a *real inscribed ellipsoid* (E'), and a *real exscribed hyperboloid of two sheets* (E''); and these three surfaces (E) (E') (E'') touch each other at the *two real points* B, B', which are the first corners of two inscribed polygons $BB_1 \ldots B_{2m-1}$ and $B'B'_1 \ldots B'_{2m-1}$, whose $2m$ sides pass respectively through the $2m$ given points (A). If these three surfaces of the second order be cut by any three planes parallel to either of the two common tangent planes at B and B', the sections are three *similar and similarly placed ellipses;* thus B and B' are two of the four *umbilics* of the ellipsoid (E'), and also of the hyperboloid (E''), when the original surface E is a *sphere*. The *closing chords* $P_{2m}P$ touch a series of real *curves* (C') on (E'), and *also* another series of real curves (C'') on (E''), which curves are the *arêtes de rebroussement* of two series of *developable surfaces*, (D') and (D''), into which latter surfaces the closing chords arrange themselves; but these two sets of developable surfaces are *not* generally *rectangular* to each other, and consequently the closing chords themselves are *not generally perpendicular to any one common surfac*

However, when (E) is a sphere, the developable surfaces cut it in two series of curves, (F'), (F''), which everywhere cross each other at right angles; and generally at any point P on (E), the tangents to the two curves (F') and (F'') are parallel to two conjugate semidiameters.

The *centres* of the three surfaces of the second order are placed on *one straight line;* and every closing chord $P_{2m}\,P$ is *cut harmonically* at the points where it touches the two surfaces (E'), (E''), or the two curves (C'), (C''), which are the *arêtes* of the two developable surfaces (D'), (D''), passing through that chord $P_{2m}\,P$. In a certain class of *cases* the three surfaces (E), (E'), (E'') are all of *revolution,* round one common axis; and when this happens, the curves (C'), (C''), (F'), (F'') are certain *spires* upon these surfaces, having this *common character,* that for any one such spire *equal rotations* round the axis give *equal anharmonic ratios ;* or that, more fully, if on a spire (C'), for example, there be taken two pairs of points C'_1, C'_2 and C'_3, C'_4, and if these be projected on the axis $B\,B'$ in points G'_1, G'_2 and G'_3, G'_4, then the rectangle $BG'_1 \,.\, G'_2B'$ will be to the rectangle $BG'_2 \,.\, G'_1\,B'$, as $BG'_3 \,.\, G'_4\,B'$ to $BG'_4 \,.\, G'_3B'$, if the dihedral angle $C'_1\,BB'\,C'_2$ be equal to the dihedral angle $C_3'\,BB'\,C_4'$. In another extensive class of cases the hyperboloid of two sheets (E'') reduces itself to a pair of planes, touching the given ellipsoid (E) in the points B and B'; and then the prolongations of the closing chords, $P_{2m}\,P$, all meet the right line of intersection of these two tangent planes: or the inscribed ellipsoid (E') may reduce itself to the right line BB, which is, in that case, crossed by all the closing chords. For example, if the first four sides of an inscribed gauche pentagon pass respectively through four given points, which are all in one common plane, then the fifth side of the pentagon intersects a fixed right line in that plane.

An example of *imaginary envelopes* is suggested by the problem of inscribing a gauche quadrilateral, hexagon, or polygon of $2m$ sides in an ellipsoid, all the sides but the last being obliged to pass through fixed points. In this problem the *last side* may be said to touch two imaginary surfaces of the second order, which intersect each other in two real or imaginary conics, situated in two real planes; and when these two conics are real, they touch the original ellipsoid in two real and common points, which are the two positions of the first corner of an inscribed polygon, whose sides pass through the $2m-1$ fixed points. Every rectilinear tangent to *either* conic is a closing chord $\mathrm{P}_{2m-1}\mathrm{P}$; but no position of that closing chord, which is not thus a tangent to one or other of these conics, is intersected *anywhere* by *any* infinitely near chord of the system. These results were illustrated by an example, in which there were three given points; one conic was the known envelope of the fourth side of a plane inscribed quadrilateral; and this was found to be the *ellipse de gorge* of a certain single-sheeted hyperboloid, a certain section of which hyperboloid, by a plane perpendicular to the plane of the ellipse, gave the *hyperbola* which was, in this example, the *other* real conic, and was thus situated in a plane *perpendicular* to the plane of the ellipse. And to illustrate the *imaginary* character of the *enveloped surfaces*, or the general non-intersection (in this example) of infinitely near positions of the closing chords in space, *one* such chord was selected; and it was shown that all the infinitely near chords, which made with *this* chord equal and infinitesimal angles, were generatrices (of one common system) of an infinitely thin and single-sheeted hyperboloid.

Conceive that any rectilinear polygon of n sides, $\mathrm{BB}_1 \ldots \mathrm{B}_{n-1}$, has been inscribed in any surface of the second order, and that n points $\mathrm{A}_1 \ldots \mathrm{A}_n$ have been assumed on its n sides, $\mathrm{BB}_1, \ldots \mathrm{B}_{n-1}\mathrm{B}$. Take then at pleasure any point P upon the same surface, and draw the chords $\mathrm{PA}_1\mathrm{P}_1, \ldots \mathrm{P}_{n-1}\,\mathrm{A}_n\mathrm{P}_n$, passing respectively through the n points (A). Again begin with P_n, and draw, through the same n points (A), n other successive chords, $P_nA_1P_{n+1}, \ldots P_{2n-1}A_nP_{2n}$. Again, draw the n chords, $P_{2n}A_1P_{2n+1}, \ldots P_{3n-1}A_nP_{3n}$. Draw tangent planes at P_n and P_{2n}, meeting the two new chords PP_{2n} and P_nP_{3n} in points R, R'; and draw any rectilinear tangent BC at B. Then one or other of the two following theorems will hold good, according as n is an *odd* or an *even* number. When n is *odd*, the three points BRR' will be situated in one straight line. When n is *even*, the three pyramids which have BC for a common edge, and have for their edges respectively opposite thereto the three chords PP_{2n}, $P_{2n}P_n$, P_nP_{3n}, being divided respectively by the squares of those three chords, and multiplied by the squares of the three respectively parallel semidiameters of the surface, and being also taken with algebraic signs which it is easy to determine, have their sum equal to zero. Both theorems conduct to a form of Poncelet's construction (the present writer's knowledge of which is derived chiefly from the valuable work on Conic Sections, by the Rev. George Salmon, F. T. C. D.), when applied to the problem of inscribing a polygon in a plane conic: and the second theorem may easily be stated generally under a *graphic* instead of a *metric* form.

The analysis by which these results, and others connected with them, have been obtained, appears to the author to be sufficiently simple, at least if regard be had to the novelty and difficulty of some of the questions to which it has been thus applied; but he conceives that it would occupy too large a space in the Proceedings, if he were to give any account of it in *them:* and he proposes, with the permission of the Council, to publish his calculations as an appendage to his Second Series of Researches respecting Quaternions, in the Transactions of the Academy. He would only further observe, on the present occasion, that he has made, in these investigations, a frequent use of expressions of the form $Q + \sqrt{(-1)}\, Q'$, where $\sqrt{(-1)}$ is the *ordinary imaginary* of the older algebra, while Q and Q' are *two different quaternions*, of the kind introduced by him into analysis in 1843, involving the *three new imaginaries* i, j, k, for which the fundamental formula,

$$i^2 = j^2 = k^2 = ijk = -1,$$

holds good. (See the Proceedings of November 13th, 1843).

And Sir W. R. Hamilton thinks that the name "BIQUATERNION," which he has been for a considerable time accustomed to apply, in his own researches, to an expression of this form $Q + \sqrt{(-1)}\, Q'$, is a designation more appropriate to such expressions than to the entirely different (but very interesting) octonomials of Messrs. J. T. Graves and Arthur Cayley, to which *Octaves* the Rev. Mr. Kirkman, in his paper on *Pluquaternions*, has suggested (though with all courtesy towards the present author), that the name of *biquaternion* might be applied.

Dr. Todd presented, on behalf of Mr. Caulfield of Cork, the rubbing of a grave-stone found in the ancient church of Keel, East Carbery, County Cork.

The stone from which the rubbing was taken is flat, and the exact size and shape of the paper; and is a species of granite, of a kind, as Mr. Caulfield thinks, quite different from any found in the neighbourhood. The back of the stone is somewhat concave, and, as Mr. Caulfield thinks, made so by art.

Mr. Caulfield stated, in a letter to Dr. Todd, that he had opened in the same district three forts, in one of which, called Aghalusky, he found Ogham inscriptions on the flags of the ceiling. "Near one of the forts, called Tullymurrihy," Mr. Caulfield says, "my attention was attracted by a rise in the ground, which I determined to have opened, and was rewarded by the appearance of loose stone masonry; and after getting larger stones removed, to the depth of seven feet, I came to an earthen floor, on one end of which were enormous quantities of bones, teeth, charcoal, and large heaps of the bones of small animals, such as field-mice, &c. The cavity consists of two circular ends, each six feet in diameter, connected together by a rectangular passage fourteen feet nine inches long."

Mr. Caulfield sent up to Dr. Todd a specimen of the smaller bones found in this chamber. When found they were in a moist state, and mixed up with something like hair very fine.

Captain T. A. Larcom presented, on the part of Mr. Learanke, a bronze sword-blade, with an iron spear-head, and some fragments of a baked clay urn, found with a skeleton buried in an erect posture in a tumulus, in the parish of Kiltale, barony of Lower Deece, County Meath. The fort is called Croghan Erin, and its situation is shown on sheet 37 of the Ordnance Survey of Meath.

"The tumulus was in the form of a frustrum of a cone, about twenty yards in diameter at the base, and raised above the level of the adjoining land about twelve feet.

"The excavation was commenced at the level of the base of the tumulus, and carried in with a nearly perpendicular face. About the centre, at the height of seven feet above the level of the base, a large flag was found, with its bed nearly level, and supported at the back by an upright flag, and at the two ends by large round stones. Under the large flag, with the earth packed around it and over it, a human skeleton was discovered in a perpendicular position, the skull being immediately below the flag, and the lower extremities a little raised over the level of the base of the tumulus. In the vicinity the spear-heads were taken up.

"When the entire tumulus was removed a pit was sunk under its base, into what appeared to be made earth, it being soft, and differing from the soil adjoining, which was limestone gravel; in this, about four feet in depth, the urn was found, and unfortunately shivered into numerous pieces by the blow of a spade. Along with the urn was found a thin piece of either brass or copper, about eighteen inches long and three inches wide, which was figured or carved round its edges, but this has not been recovered or traced."

Colonel Jones presented, on the part of the Board of Works, some coins found in the river Inny, about a quarter of a mile below Ballycooly bridge, County Westmeath.

By command of His Excellency the Lord Lieutenant, Colonel Jones exhibited five gold rings or bracelets, found near Strokestown, County Roscommon.

Dr. Petrie and Sir William Betham made some remarks as to the probable age of these rings, which Mr. Petrie was disposed to think might come down so late as the silver bracelets found frequently in Ireland and England, as these gold bracelets very much resembled them in form and design.

Dr. Madden stated, in reference to the gold rings exhibited by Colonel Jones, that he had frequently seen, both on the east and west coasts of Africa, rings worn by the women exactly similar. These rings, he also explained, passed as the currency of the country. The fact of the discovery of these rings in Ireland appeared to indicate ancient commercial relations between this country and Africa.

August 2nd, 1849. (Extraordinary Meeting.)

JOHN ANSTER, LL.D., Vice-President, in the Chair.

On the recommendation of the Council, His Royal Highness the Prince Albert was elected an Honorary Member of the Academy.

The Rev. Dr. Wall, Vice-Provost, Sir Wm. R. Hamilton, LL.D., John Anster, LL.D., and George Petrie, LL.D., were appointed a deputation to present the following Address to Her Majesty:

" *To the Queen's Most Excellent Majesty.*

" May it please your Majesty,

" We, the President and Members of the Royal Irish Academy, humbly beg leave to offer our respectful and hearty congratulations on the occasion of your Majesty's first visit to Ireland.

" Inspired with feelings of devoted attachment to your Majesty's crown and person, we rejoice in the presence of our Queen, and accept it as a happy omen of more prosperous times.

" As members of a society incorporated for the promotion of Science and Literature in Ireland, we have peculiar reasons to hail your Majesty's arrival amongst us.

" We know that whilst your Majesty has, with distinguished prudence and energy, discharged the arduous duties of governing and protecting the State, your Majesty has ever looked with earnest solicitude on the progress of all institutions designed for the diffusion of knowledge, and calculated to elevate the moral and intellectual condition of your Majesty's subjects.

"It was for the purpose of promoting and extending such pursuits in Ireland that your Majesty's royal ancestor bestowed a charter of incorporation upon our Academy; and its Members, keeping aloof from the strife of parties, and undiscouraged by the difficulties which surrounded them, have ever since endeavoured faithfully to carry into effect the objects of their institution.

"That your Majesty may be long spared in health and happiness to reign over us, and permitted to witness the complete success of all your Majesty's benevolent endeavours to establish peace and prosperity, is the constant and earnest prayer of your Majesty's faithful and most obedient Servants."

[This Address was accordingly presented at the Levee held by her Majesty, in the Castle of Dublin, on the 8th of August.]

The following Address to His Royal Highness the Prince Albert was also adopted; and the Secretaries were directed to transmit it in the usual manner:

"*To his Royal Highness Prince Albert.*

"MAY IT PLEASE YOUR ROYAL HIGHNESS,

"We, the President and Members of the Royal Irish Academy, desire your Royal Highness to accept our sincere and respectful congratulations on the occasion of your visit to Ireland.

"Your Royal Highness is well known to us as the patron of those objects for the promotion of which our Academy was founded. Not only recognising the nobleness of intellectual pursuits, but yourself a participator in the pleasures which attend them, you have done much to encourage the efforts and to reward the success of all who cultivate them within these realms.

"We, therefore, confidently indulge the hope that your visit to Ireland will be productive of great benefits to it. We feel sure that the presence of a Prince, so eminent for wisdom and goodness, will stimulate the energies of all who are labouring here to advance the national prosperity ; and we hope that a nearer view of this country, and a better acquaintance with its people, may deepen the sympathy with which you have been accustomed to regard it.

" After a season of gloom and trouble, brighter prospects seem now opening upon Ireland. Whilst the establishment of peace and the prospect of returning plenty fill the hearts of all Her Majesty's faithful subjects with thanksgiving, we have the crowning happiness of welcoming our Queen amongst us, and feel in her presence the best proof of her gracious and affectionate interest in our welfare.

" She visits us, accompanied by you and by her Royal Children: she thus makes Ireland for the time her home. Would that it were for a longer period, that we might more fully contemplate the example of domestic virtue which reigns within your happy circle; that, in the more frequent sight of our Sovereign, we might gratify the longings of affectionate loyalty with which we regard her person; and that our Princes, when grown up, might have some of the happy recollections of childhood associated with the name of Ireland."

ANSWER.

" *Viceregal Lodge, Aug. 9th,* 1849.

" SIR,—I have received the Address of the President and Members of the Royal Irish Academy, and have had the honour to lay it before his Royal Highness the Prince Albert.

" I have received the commands of the Prince to request you to accept for yourself, and convey to the Members of the Society, his Royal Highness's best thanks.

" I have the honour to be, Sir,
" Your most obedient humble Servant,
(Signed) " C. B. PHIPPS.

" *To the President of the*
Royal Irish Academy."

November 12th, 1849.

REV. HUMPHREY LLOYD, D.D., President,
in the Chair.

Lord William Fitzgerald was elected a Member of the Academy.

A collection of antiquities, found near Athlone, was presented by the Commissioners for the Improvement of the Navigation of the Shannon.

Colonel Jones, on the part of the Commissioners of Public Works, presented to the Academy some antiquities found in the neighbourhood of a cavern near Cushendall, in the county of Antrim.

Along with the list of the articles, Colonel Jones handed to the Secretary a description of the cavern, drawn up by Denis Black, one of the persons employed by the Commissioners in the construction of the pier at Redbay Dike.

According to this account the cavern consisted of two parts; the first, running due south from the entrance, was fifteen feet long, four and a half high, and about four and a half wide, and of very irregular formation, the whole being coated with carbonate of lime from one to six inches thick. The floor, which is sixteen and a half feet above the level of high water mark, contained water-worn stones, with bones of cattle and other animals, all firmly imbedded in the lime, and encrusted with it. The second part of the cave ran westwards from the southern extremity of the first, continuing for about nine feet, but so contracted by stalactites that it could not be explored. This smaller gallery intersects the main trap dike, in which the cavern is formed, at right angles to the plane of its direction, whilst the larger cavern runs parallel to the dike. Outside the entrance, and close to it, were found the remains of two human skeletons, not lying in the usual position: they appeared, however, to have been disturbed in the operations of quarrying. Promiscuously around them were bones of various animals imbedded in a mass of matter, which seemed to consist principally of *debris* from the higher parts of the dike; but it appeared to contain also a large proportion of organic matter.

At a point about ten yards south-west of the cavern were found two bronze axes and two silver coins.

The special thanks of the Academy were voted to the Commissioners for their valuable donations to the Museum.

Joseph Huband Smith, Esq., stated that in the beginning of the month of July last, in passing Redbay, near Cushendall, he learned that several skeletons had been discovered in quarrying for stones for the quay or pier then in progress.

Mr. Pender, the overseer of the works, informed Mr. Smith that the remains of about six skeletons had been discovered in what he supposed might have been originally a cave, the top and sides of which had fallen in through time; and that along with the skeletons were discovered two bronze axes, one stone axe, and two small silver coins, all of which he produced to him. The bronze axes were much corroded, and covered with an incrustation of rust and verdigris; they did not appear to have been in any degree ornamented. The stone axe was much smaller, and of the ordinary form. The coins are both engraved in "Ruding's Annals of the Coinage of Great Britain, &c.:" London, 1840. The one is a coin of Berhtulf, King of Mercia, as Ruding states, A.D. 839. The legend being on the obverse BERHTVLF. REX., on the reverse BRID. MONETA. The second is a coin of Ceolnoth, Archbishop of Canterbury in the same year. The legend on the obverse is CIALNO. ARC., and on the reverse VVNERE. MONETA. Both coins are in excellent preservation.

About a month afterwards Mr. Prender showed Mr. Smith two other bronze axes, subsequently discovered in quarrying at the foot of the same cliff, but lower down, not much above what may have been high-water mark.

Mr. Smith observed that the discovery of stone and bronze weapons together, and in connexion with two coins of the ninth century, appears to be a fact of no little importance in fixing a period in which these weapons were apparently in actual use.

Sir W. Betham communicated the following account of a meteor observed by him:

"On Friday, the 2nd of November, about five minutes before five o'clock, P. M., I had just entered the gate of my house near Blackrock, when my attention was drawn to a luminous object approaching from the east towards me, at an elevation (as I supposed) of about 500 feet from the earth. Its apparent velocity was not greater than that of a rook in steady flight. It seemed to pass me at a distance of not more than 100 yards to the south, and, after keeping its elevation steadily, to disappear not more than 600 or 700 yards to the west of the place where I was standing.

"It was a round, very brilliant ball, apparently about nine or ten inches in diameter, emitting flame and sparks from all its sides, and leaving behind it a luminous train, in which sparks continued visible at some distance from the ball for a few seconds.

"I watched its progress carefully, but could not observe any tendency to descend towards the earth while it continued inflamed.

"It disappeared suddenly, but, although I looked very anxiously, I saw no solid residuum fall.

"It was seen by a servant of mine passing over the hill going up to Kingstown, on her way from the sea; and she tells me it passed almost directly over her head. She says she thought it had been a rocket, but that it flew straight on, instead of going upwards.

"It was daylight, and by no means a dark evening. I heard no hissing or any other noise, nor was there any report or explosion audible when the meteor disappeared.

"The wind at the time was nearly due west, just opposite to the course of the meteor's progress."

Sir William Betham exhibited a rough sketch of the meteor.

George Alexander Hamilton, Esq., M. P., communicated the following note respecting the appearance of the meteor:

About ten minutes before 5 o'clock, P. M., on Friday, the 2nd, as Mrs. Hamilton was walking near Balbriggan, she observed a very brilliant meteor to the south, or S. S. E., at an angle of about 75° from the horizon. Its brightness was almost dazzling. The colour was nearly that of gas-light. It was then round, the size of an immense star, the outline very clearly defined. Instantaneously it increased in size, and changed into the form of a common paper kite. It then moved slowly, describing an arch, towards the west. As it began to descend, the pointed part threw off small balls, decreasing in size. These balls, constituting a kind of tail, separated from the globe almost immediately, and became extinguished. The globe continued the same size as it advanced along the arch, until it suddenly disappeared at some distance above the horizon.

Some country people at Ballygarth, between this place and Drogheda, state that they saw an extraordinary ball of fire, which appeared to fall to the ground.

Robert Mallet, Esq., read the following paper on the appearance of the meteor, and the method adopted by him to estimate its altitude and velocity:

"On Friday evening last, the 2nd of November, 1849, while returning to town, and waiting at Salt Hill station for the train, I observed, along with my eldest son, who accompanied me, a meteor of unusual size and brilliancy; and accidental circumstances having enabled me to make some tolerably accurate observations upon it, and to obtain those of other simultaneous observers, I deem the whole as possibly worthy of permanent record.

"I was standing at Salt Hill station, with my face towards the east, and looking upwards, when, at about 30° of elevation, a bright light bearing a short tail suddenly appeared, and in motion. Its apparent motion was upwards, and it passed almost directly over my zenith, or perhaps about 10° to the south of it, and, continuing to move in a vertical plane almost precisely parallel to the line of rails at Salt Hill station, disappeared again at about 30° or 35° of elevation on the opposite or western side of our zenith. At the moment of its disappearance, I ran into the station house, and found the railway clock there shewed 54¾ minutes past 4 o'clock. I set my own watch accurately by this clock, and on coming into town ascertained, by comparison with the chronometer of Mr. Law of Sackville-street, that it was four minutes fast. Hence the true time of the extinction of the meteor was 50¾ minutes past 4 o'clock, mean time, within an error of twenty seconds at the most.

"The day had been fine. It was clear daylight at the time, so that the faces of persons standing on the platform (many of whom saw the meteor) could be discerned clearly at fifty yards' distance. The sky was serene overhead, with a very few stars of the first magnitude just becoming visible, and some light, scirrus clouds tinged reddish by the sunset. The horizon all round presented a soft, neutral, grey haze, most dense over Dublin, and becoming evanescent at about 30° of elevation.

"The meteor seemed to start into existence and to disappear just above the confines of the haze (but was not eclipsed by it), with the tail already formed and at first pointing towards the earth, or in rere of its apparent motion. It was moving at the first instant it was visible; passed across overhead apparently in an enormous arch, the highest point of which did not seem to the eye to be above a few hundred feet, and disappeared by sudden extinction in the south-west, the tail being then vertically above, as on its appearance it was vertically below the nucleus of light.

"Its apparent velocity of motion was rather faster than that of a common rocket, and the whole time of visible traject was probably about four or five seconds. At the first moment it was taken to be a rocket by several persons present, but an instant's observation of its intense light and short tail shewed it to be no artificial fire.

"I fancied I heard a faint rushing or hissing sound, and immediately after asked my son, did he hear any noise. He replied in the negative, and although the impression was strong on my own mind, I fancy that the noise was but imaginary, and the effect of constant association with the noise of a rocket which the meteor so forcibly resembled.

"The appearance of the meteor itself, of which I present a diagram, was of a body or nucleus of intense bluish white light; the forward portion keenly defined, and having a sort of conoidal or elipsoidal shape, something the form of Newton's solid of least resistance, while the rereward portion was irregularly radiating or brush-like, and throwing off laterally flashes of light, at angles up to 50° or 60° from its line of motion.

"The apparent size of the head was something larger than the disk of Jupiter when nearest to us and seen best by the naked eye, but the light greatly more intense, as much so as that of a powerful galvanic battery, one of which I had just quitted using during the day, and the close similarity to the light from which at once struck both my son and myself.

"The tail was about twenty apparent diameters of the body in length; it was of a reddish hue, and far less brilliant than the body. It was at no time perfectly continuous, nor was it brush-like, but rather like a trail of sparks or flashes of yellowish red light left behind, and becoming rapidly extinct behind the body. Possibly the reddish tinge of the tail light was merely complementary to the bluish light of the nucleus. At about the highest apparent point of its course, the tail suddenly broke in two, as it were, and left a blank space between its remains which followed, and the body itself, for perhaps one-fifth of a second or thereabouts, during which interval the end of the divided tail next the body was larger and more luminous, as if a subordinate body or nucleus was temporarily being formed. The tail was of about the same length, and the body of the same magnitude and brilliancy, during the whole of its course.

"As it descended towards the west I watched it eagerly, to see if any solid body would drop from it, but there was no sign of any. It seemed to go out, as it appeared, with all the suddenness with which the arc of light appears and disappears, on making or breaking connexion of the poles of a large galvanic battery.

"There was no sound as of explosion at the moment of its extinction, nor any train of smoke or vapour left after it.

"The general shape of the meteor was that of a nail with the head flying foremost.

"On my return home at half-past 5 o'clock, I found that two other members of my family had each separately seen the flight of the meteor from different parts of our dwelling-house, at 98, Capel-street, Dublin. On examining them as to the time, I satisfied myself that they had both seen the same meteor, and the same that we saw at Salt Hill. I was also able to get each party to stand precisely in the spot he had witnessed the phenomenon from, and (the horizon being limited luckily in this case by buildings in all directions) to point out to me the precise points over those buildings, at which the meteor appeared and disappeared.

“ Then, by the aid of a theodolite, I obtained two separate measures for the greatest apparent altitude of the trajectory to each of these separate observers.

“ The angle of elevation above the horizon given by one was 46° 5′, and by the other, 43°; and the course or plane of trajectory corresponded closely with that observed by us at Salt Hill, viz., from N. E. to S. W., 110° west of north. I find the distance in a straight line from my dwelling-house to Salt Hill station, as measured on the large scale map of the Ordnance Survey, is six miles and a quarter, as nearly as possible, or 33,000 feet. I have subsequently obtained from a third observer, close to the same locality, a third angle of apparent maximum elevation, which gives 53° 5′. Reducing these by a simple trigonometrical operation, and assuming all the observers to have been on the same horizon or level (which they were, within about fifteen feet), the actual culmination of the meteor, or greatest elevation above Salt Hill, would be from each of the observations as follows:

	Elevation.	
43° 0′ . .	30,210 feet,	= 5·72 miles.
46° 5′ . .	34,110 ,,	= 6·46 ,,
53° 5′ . .	39,000 ,,	= 7·38 ,,

“ The latter observation was most likely (by circumstances) to be somewhat in error in angular excess. I am, therefore, on the whole, disposed to conclude that the actual elevation was about six miles. The meteor was, therefore, in air of little more than one-fourth the density of that at our surface, and at its greatest altitude might have been seen at a distance of above 200 miles.

“ It was seen from parts of the county of Carlow, and I should hope that several other observations may yet be obtained, by which its altitude (the most important of all elements at present to the study of these mysterious phenomena) may be still more correctly ascertained.

“ Assuming the flight of the meteor to have been in a great circle, and at the average altitude above the earth's surface, as already found, of 35,000 feet, and the elevations having been observed by me, at Salt Hill, at the moments of appearance and of disappearance, we are enabled to obtain the length of the trajectory and the velocity of motion nearly; considering its flight to have been in a right line, which may be done without material error. The zenith distance of the body at the moment of apparition or of disappearance is

$$\frac{180° - (30° + 30°)}{2} = 60° = B,$$

and calling the altitude $a = 35{,}000$ feet,—we have, putting C for the entire trajectory,

$$\frac{C}{2} = a\ \frac{\sin B}{\text{cosin } B} = a \tan B,$$

from which we obtain $\frac{C}{2} = 60{,}621$ feet, and $C = 121{,}242$ feet, $= 22{\cdot}92$ miles; which, taking the time of flight at four seconds, gives a velocity of 30,310 feet per second, or 5·74 miles, and at five seconds a velocity of 24,248·5 feet per second, or 4·59 miles. The least velocity being thus above twenty times that of sound in air, and almost that of some of the planets.

"The nucleus or body of the meteor, I have stated, appeared rather larger than the disk of Jupiter when largest. It then subtends a visual angle at the earth of 40″, is distant 51,566 diameters of our earth, and its own diameter is 88,000 miles; hence we are enabled readily to calculate the actual diameter of the nucleus of the meteor, the height or distance of the eye from which we have found.

"The result of this operation gives a diameter for the nucleus of 95·4 inches, or nearly eight feet.

"Where there is no knowledge, conjecture is allowable, provided it be not that *mera palpatio* against which Bacon warns, but rather tending to some guiding hypothesis.

"In the present instance the senses were powerfully impressed with the vivid resemblance of this luminous mystery, during every moment of its flight, to *a continuous discharge, at one moving point, of the most intense electric light*, and equally impressed with the absolute want of any solidity, or power of conveying to the senses any notion of weight or momentum, which the body suggested. May it not ultimately, then, be found, that these strange apparitions are but another form of electric discharge, in restoring the equilibrium of this great cosmical force in the higher regions of our atmosphere, of which we already know two other forms, at least in lightning and the aurora, and a third, that of the fire-ball, has been described by Arago (*Annuaire* for 1838)? Although hundreds of square miles of oppositely electrified cloud, or of strata of air, come at once within striking distance, yet the lightning flash starts out from one to the other but at a single point of space. Why may not then the electric discharge take place along a line of successive points? If so, many of the hitherto observed phenomena of meteors would be presented by this continuous or sustained blaze of lightning moving along the line in which was the locus of all the successive points of discharge.

" A good deal might be stated in rendering more probable this notion, by considering the prevailing direction of observed motion of meteors, and the periods of the year at which their occurrence has been most frequent; but I forbear for the present to enlarge upon it.

" I have only to add to the preceding observations, that on going to Killiney Hill at half-past 7 o'clock on the morning of the 2nd November, I passed through and got above a singular fog which lay perfectly at rest up to about half the height of the hill, and was seen enveloping Howth to about two-thirds of its height, with a keen and perfectly level upper surface, from which we emerged as from an opaque fluid.

" That on coming into town at half-past 5 o'clock in the evening of the same day, after having seen the meteor, we plunged suddenly at the River Dodder into a similarly dense mass of fog, which we again passed out of before reaching Westland-row Terminus. I know not how far, if at all, such fogs may be found connected with luminous meteors.

"On the 30th of October last, at about 5 o'clock in the evening, being on the strand of Killiney Bay, my son and I also saw a meteor, very much like that I have just described, flying horizontally, and disappearing in the opening between the obelisk and Rochestown hills. It was too distant and little seen to enable any accurate observation to be made; but it was, like the present, at the first glance taken for a rocket."

The Rev. Dr. Todd read the following extract from a letter from John T. Rowland, Esq., giving an account of the discovery of a rudely cut stone found near Ardee:

"I send you herewith, for presentation to the Royal Irish Academy, an ancient basin or urn, which I found in January, 1848, on the lands of Paughenstown, about two and a half miles east of Ardee, where caves had been discovered by workmen employed in deep-draining a large field which had been laid down for many years, and which in appearance was almost level, presenting no indication whatever of tumuli or mounds.

"When I arrived at the place, there were, in the middle of the field, two great heaps of stones, the scattered remains of the caves or chambers. It appeared that the workmen (in making a drain from north to south) came upon a wall of dry stones, at a depth of about five feet from the surface; in following which they found it to be one of two walls running parallel, about two and a half feet asunder, forming a passage covered with large flags, running on to a distance of about ten feet, when it turned to the west, and opened into a circular chamber about twelve feet in diameter and ten feet in height, having a conical roof, capped on top by a large flag about six feet in diameter, which still lay on the field unbroken. In this chamber the floor was flat, and strewed with pebbles, but contained nothing possessing interest, except a huge clay ornamented pipe, the shank of which was as thick as a man's forefinger. The passage then proceeded in a southern direction, keeping in a line with the place at the north where the passage was first discovered.

"At a distance of about twenty feet south of the first chamber was found another circular chamber about six feet in diameter and eight feet in height, having a very singular floor. As I was not present when these chambers were opened and broken up, I cannot vouch for what I am now going to describe, but the workmen all agreed in a description to the following effect:

"This chamber was surrounded by seats or stone benches placed against the walls, from which the floor descended in a concave manner to a point in the middle (thus making the bottom of a like shape to the roof of the chamber), and these benches formed steps down to the point in the centre.

"The passage then proceeded still southward for four or six feet, at which place further progress seemed denied by a huge flag placed on its edge across the passage, and firmly set in on either side. This, however, seems to have aroused the inquisitiveness of the workmen, and was soon broken through; but all beyond was mystery; for the passage, though still continued southward, was not covered with flags, and was completely choked with clay and small stones. I presume that this was in reality the proper entrance to the chambers, and that it had centuries ago been opened by destructive hands, and carelessly filled up when their object was accomplished.

"All the large flags and other stones which had formed the passage and chambers were thrown up, and broken by the iron hammers of the workmen to make draining stones; and when I arrived on the spot nothing was visible but about 100 tons of stones, the trench and holes marking where the passages and chambers had once been. However, I got some men, and set them to work at the south end of the trench, in order, if the passage still continued (as the workmen informed me) that I might see if it led to other chambers. To work they went; but having gone about eight feet in continuation, and a depth of six, and in some places seven feet, I gave up hopes of any further discovery. The walls of the passage still continued running now south-eastward, the tops of the walls being five feet beneath the surface of the field; but this passage was filled up with clay, and no flags covered it across.

"In this cutting, however, I found an ancient Irish quern, and beside it (both at a depth of four feet) a bit of charcoal.

"Looking carefully among the heaps of stones which had composed the chambers, I found the basin or flat urn I now send you. This the men thought had been thrown out of the smaller of the two chambers.

"The flags of which these chambers had been made were of two kinds, clay-slate and red sand-stone, there being much of the latter. On one flag of the former, and half imbedded in the substance of the stone, were sea-shells of the ammonite.

"I brought away the quern, the basin, and a piece of the flag covered with shells.

"I hope the basin, though rude in form, may prove interesting.

NOVEMBER 30TH, 1849. (Stated Meeting.)

The REV. HUMPHREY LLOYD, D. D., PRESIDENT, in the Chair.

ON the recommendation of the Council, the following were elected Honorary Members of the Academy:

In the Department of Science.

ALEXANDER VON HUMBOLDT.

In the Department of Polite Literature.

JACOB GRIMM.
FRANZ BOPP.
KARL REICHARD LEPSIUS.
FRANÇOIS PIERRE GUILLAUME GUIZOT.
LEOPOLD RANKE.

Captain Larcom stated that the meteor noticed at the last meeting had been observed in the county of Waterford by Lady Stuart de Rothsay. Her Ladyship had just left the glebe house of Kilmeadan, when the meteor caught her eye, appearing to light on the belfry of the church.

The Rev. Samuel Haughton mentioned its having been seen in the Queen's County, and also in the County Carlow, moving from the south-east to the north-west. One of his informants stated that it became invisible at a considerable altitude above the horizon.

Sir William Betham read the following account of a squared stone in the Museum of the Royal Irish Academy, sent there from Navan, in the County of Meath, by W. F. Wakeman, Esq.

"This stone appears to have been a portion of the shaft of a market cross, and served to commemorate certain members of the ancient family of Nangle, or De Angulo, Barons of the Navan, in the Palatinate of Meath.

"It was erected by Martin Nangle, Esq., eldest s Patrick Nangle, Baron of the Navan; by his wife, C daughter of Martin Blake, of Athboy, in that county died before his father in 1585. He was married to daughter of Sir Francis Herbert, of Ballycotland, in county of Kildare, ancestor to the Herberts of Durro whom he had Sir Thomas Nangle, Baron of the Navan, succeeded his grandfather, Patrick, on his death in Nicholas Herbert, eldest son of Sir Francis, married C rine, sister of said Martin Nangle.

"I have made a rough sketch of what remains of t scriptions on each side of the stone, to which I now refe

"No. I. contains a shield of the arms of Martin Na impaled with those of his wife, viz.: first and fourth a three lozenges in fess or, for Nangle; second and third a a fess between five martlets, three in chief, and two in gules, for Dowdall.

"Impaled with per pale, azure and gules, three rampant, two and one, argent, within a border gobony gent and sable, for Herbert.*

"Over the shield are the names NANGLE AND HARB

"No. II. is the following inscription :—

I O
SVLINVS
DE ANGVLO
THE FIRST
BARRON OF
THE NOVAN.
IS
IS=
GIVE
HIM BY SIR
HVGHE
DE L CIE

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* The colours or border are not represented on the stone.

"No. III. is the representation of a lady in the costume of the time of Queen Elizabeth's days, under which is:

PHIL
IPPVS·N·
ALIQVANDO
BARO DE
NOVAN FO
RVM AC
NVNDIN

"No. IV. On this side is a head with wings, three globes, or roundlets, two above and one below: over all a naked human figure, with the right hand up to the head, the left extended, holding an hour-glass. What these emblems are intended to signify I leave to the imagination and ingenuity of others.

"Of No. I. I have already given an explanation.

"No. II. This portion of the inscription gives a hint at the history of the family of Nangle.

IOSVLINUS DE ANGVLO THE FIRST BARRON OF THE NOVAN. . . . . IS . . . . IS . . GIVEN HIM BY SIR HVGH DE LACIE. . . .

"Gilbert de Angulo and his son, Joceline, came over to Ireland with Earl Strongbow, who made Gilbert a grant of Magheragalen. His name appears as a witness to the grant of Howth to Sir Almeric de St. Laurence. He had two other sons besides Joceline, Hostilio de Angulo, who obtained a grant of lands in Connaught, afterwards and now called, after him, the barony of Costello, in the county of Mayo. His descendants were called *Mac Hostilio,* corrupted into Costello, and his descendants and representatives are still possessed of a good estate in that barony. Another son settled in the county of Cork, having obtained a grant of lands in the barony of Fermoy, called Moneaminy. Silvanus Spenser, son of Edmond, the poet, married Ellen, eldest daughter of David Nangle, or Nagle, of Moneaminy, who died in 1637. Sir

Richard Nagle, Attorney-General to King James II., was of this family, as is Sir Richard Nagle, of Jamestown, in the county of Westmeath.

"Joceline de Angulo, above mentioned, had a grant of the barony of Navan from Sir Hugh de Lacy, and thus, as stated in the inscription, became the first Baron of the Navan, and one of the magnates of the palatine honour of Meath.

"Gilbert de Angulo, his son, second Baron, rebelled against King John, but, having submitted, had a pardon under the great seal, now on record on the Close Roll of the year 1207 in the Tower of London.

"William de Angulo, son of Gilbert, was included in his father's pardon, and paid 300 marks for a writ of restitution of his lands, as appears in an entry on the Close Roll in the Tower of London for the year 1210.

"Philip de Angulo, son of William, had livery of his lands in 1215. Walter de Lacy, then lord of Meath, granted and confirmed to him his lands, &c., in Meath, to which grant Geoffrey de Montemarisco (or De Marisco), Lord Justiciary of Ireland, was a witness. This Philip is the person alluded to in the inscription as "*aliquando Baro de Novan*," there having been no other Philip Baron of the Navan.

"John Nangle, Baron of the Navan, who died in 1517, married Elinor, daughter and heir of Sir Thomas Dowdall, Knight, and this marriage is noted by the quartering of the arms of Dowdall on the stone No. I.

"Patrick Nangle, Baron of the Navan, the grandson of Martin, became a Protestant, and married Mary, daughter of Sir Richard Bolton of Brazil, Knight, Lord Chancellor of Ireland, and had an only daughter, wife of Dudley Loftus, Esq., LL. D., Judge of the Prerogative Court of Armagh. He was succeeded in his barony by his brother, George Nangle, who died in 1676, leaving a son, John Nangle, Baron of the Navan, living, 1685, having two sons, Thomas and Jasper, and four daughters.

" There were many junior branches of this ancient family, of which the representatives still exist. The Nangles matched with the first and most noble families in Ireland.

" It is to be regretted that the remainder of the stone has been lost. It may hereafter turn up."

Dr. Anster exhibited a small volume, said to have been found on the person of the Duke of Monmouth at the time of his arrest. It is a manuscript volume of 157 pages. It was purchased at a book-stall in Paris, in 1827, by an Irish divinity student; was by him given to a priest in the county of Kerry, and, on the priest's death, became the property of the present possessor. There has been no opportunity of comparing the handwriting with that of the Duke of Monmouth, but Dr. Anster thinks that there can be little doubt of its being genuine, and a considerable part, if not the whole, in the Duke's handwriting. Some parts, that are altogether unimportant, except as showing the kind of things that had interest for the compiler, and which are but extracts from old receipt books and abridgments of English history, are written in the same character with memorandums of a private and personal kind. He then referred to a paper in the last edition of the Harleian Miscellany, giving an account of the Duke's capture, and to Sir John Reresby's Memoirs, as proving that all the papers, &c., found on the Duke's person, were taken to James the Second.

" The papers and books that were found on him are since delivered to His Majesty. One of the books was a MS. of spells, charms, and conjurations, songs, receipts, and prayers, all written with the said late Duke's own hand."—*Harleian Miscellany*, vol. vi. p. 323.

Sir John Reresby describes a book of the kind as taken from the Duke's person. As he tells the circumstance, it would seem to have been taken from the Duke's person at the time of his execution, and not at that of his capture. But there is either some inaccuracy in his account of the matter, or—which is just as probable—some inaccuracy in the printed copy of his Memoirs: for the carelessness with which many of these old books are printed is such as exhibit too frequently alterations of the meaning. "I say this," added Dr. Anster, "having been astonished at the discrepancies between the printed editions, for instance, of 'Spenser's View of the State of Ireland,' and the manuscript copy of the work in the library of Trinity College, Dublin."

Sir John Reresby's words are: "Out of his pocket were taken books in his own handwriting, containing charms or spells, to open the doors of a prison, to obviate the danger of being wounded in battle, together with songs and prayers."

Barillon describes the book the same way: "Il y avoit des secrets de magie et d'enchantment, avec des chansons, des recettes pour des maladies, et des prières."

In a note of Lord Dartmouth's to the modern edition of Burnett's "Own Times" we have the following statement:—"My uncle, Colonel William Legge, who went in the coach with him to London, as a guard, with orders to stab him if there were any disorders on the road, showed me several charms that were tied about him when he was taken, and his table-book, which was full of astrological figures that nobody could understand; but he told my uncle that they had been given to him some years before in Scotland, and he now found they were but foolish conceits." Mr. Macaulay, in the account of the Duke's capture, mentions, as taken on his person "an album, filled with songs, receipts, and charms." The passages which are most curious in the book are those which give some memorandums of his journeys on two visits to the Prince of Orange, in the year previous to his last rash adventure. His movements up to the 14th of March, 1684–5, are given. The entries do not seem to be of much moment; but they may accidentally confirm or disprove some disputed points of history. There is an entry without a date, describing the stages of a journey in England, commencing with 'London' and 'Hampstead;' it ends with 'Todington.' Todington is a place remarkable in the history of the Duke. Near it was the residence of Lady Henrietta Maria Wentworth, Baroness (in her own right) of Nettlestead, only daughter and heir of Thomas Lord Wentworth, grandchild and heir of the Earl of Cleveland. Five years before the Duke's execution her mother observed that she had attracted his admiration, and she hurried her away from court to Todington or the neighbourhood; and in 1663, when, after the failure of the Rye-house Plot, Monmouth was banished from the royal presence, it was to Todington he retired. When, on retracting the confession which he had made on the occasion, he was banished the kingdom, the companion of his exile was Lady Henrietta Wentworth. "I dwell on this," said Dr. Anster, "because the accidental mention of Todington seems to authenticate the book; the name of Lady Henrietta Wentworth does not occur in it, and the persons in whose hands the book has been since it was purchased in Paris do not seem to have noticed the name of Todington, or to have known that it had any peculiar relation to the Duke's history. It occurs twice in the book; once in the itinerary I have mentioned, and again in a song, which is probably the Duke's own composition:

'SONG.

'With joy we leave thee,
False world, and do forgive
All thy false treachery,
For now we'll happy live.
We'll to our bowers,
And there spend our hours;
Happy there we'll be;
We no strifes can see,
No quarrelling for crowns,
Nor fear the great one's frowns,

Nor slavery of state,
Nor changes in our fate.
From plots this place is free,
There we'll ever be;
We'll sit and bless our stars
That from the noise of wars,
Did this glorious place give,
That thus we happy live.'

"In the margin is the following substitution (with the word '*or*' prefixed) for the line before the last:

'Did us Todington give.'

"In Macaulay's History we find the following affecting mention of Lady Henrietta Wentworth. He has just described Monmouth's execution and burial:—'Yet a few months, and the quiet village of Toddington in Bedfordshire witnessed a yet sadder funeral. Near that village stood an ancient and stately hall, the seat of the Wentworths. The transept of the parish church had long been their burial-place. To that burial-place, in the spring which followed the death of Monmouth, was borne the coffin of the young Baroness Wentworth of Nettlestead. Her family reared a sumptuous mausoleum over her remains; but a less costly memorial of her was long contemplated with far deeper interest. Her name, carved by the hand of him she loved too well, was a few years ago still discernible on a tree in the adjoining park.'" Dr. Anster then pointed to the state of the book, which he produced. There were the remains of silver clasps which had been torn off, and a part of the leather of the covers at each side was torn away, seemingly for the purpose of removing some name or some coat of arms with which it had been once marked. "On this account," said Dr. Anster, "and in connexion with the book being found in Paris, I was anxious to cite such passages from the old narratives of the Duke's capture and execution as trace the Duke's papers to the possession of James the Second. Had this little volume the arms of the Duke of Monmouth on it,—either his own or the royal arms, which the Duke was not unlikely to have assumed,—and had it been among James's manuscripts connected with the history of his own times, the defacement of the binding in this way would be additional evidence of the authenticity of the volume; for the history of James's manuscripts is this; that at the period of the French Revolution the persons in whose custody they were, being fearful of the suspicion likely to arise from their possession of books with royal arms on them, tore off the covers and sent the books to St. Omer's. The after fate of the larger books was, that they were burned; some small ones, we are distinctly told, were saved from this fate, but seem to have been disregarded, and all trace of them lost. The Abbé Waters was the person with whom George the Fourth negotiated for the Stuart papers, and from whom the volumes which have since appeared as 'Clarke's Life of James the Second' were obtained; and it is from the Abbé Waters we have the account of the destruction of King James's autograph papers. I do not know whether it is worth observing, that on the inner cover of this volume we find written the words, 'Baron Watiers,' or 'Watrers.' It is not distinctly enough written for me to be quite sure of the letter between the 't' and the 'e,' but there is a letter, and the name is not *Waters* as now spelled. It is said by Sir John Reresby, that in the book found on the Duke's person there were 'charms against being wounded in battle.' I do not find any such, but there are some prayers against a violent death, which may have been his own, but have, to me, rather the appearance of having been transcribed from some devotional book. I suspect there is a mistake in supposing that this book contains any charm for breaking open prison doors, and I think it likely that Sir John Reresby was misled in the same way that I was for a moment. There is in page 7 a charm in French to procure repose of body and mind, and deliverance from 'pains.' The word for pains is written in a contracted form, and might as well stand for prisons, but on examining the context it is plainly the former word which is to be looked for. The charms and conjurations are in general for the purpose of learning the results of 'sickness in any particular case;' of determining whether 'friends will be faithful,' &c. We have 'cures for the stone,' and incantations 'to make grey hair grow black.' This book confirms the character which history gives us of the Duke, as a weak, frivolous, and superstitious man, not unlikely to be influenced for good or evil by the persons and circumstances in which he found himself; and, in its degree, it does something to illustrate the spirit of the age in which he lived."

DECEMBER 10TH, 1849.

The REV. HUMPHREY LLOYD, D. D., PRESIDENT, in the Chair.

The REV. HENRY KING, LL. D., was elected a Member of the Academy.

Mr. Ball, on the part of Abraham Whyte Baker, Sen., Esq., of Ballaghtobin, a member of the Academy, and one who has always endeavoured to promote its objects, presented accurate casts of two bear skulls found in the county of Westmeath. The following is a summary of the information Mr. Ball has been able to obtain relative to these very interesting relics of a powerful species long extinct in this island. Mr. Underwood, the well-known and industrious collector of antiquities, who has rescued from destruction many of the best specimens of human art now in the Academy's museum, being in 1846 on one of his tours through the country, discovered at the house of Mr. Edward Fermon, of Forgney, County Longford, on the borders of Westmeath, between Moyvore and Ballymahon, the skull of an animal to him unknown. This he lost no time in securing, and in the following year obtained a second specimen, found in the same place, in a cut away bog, about seven feet from the original surface. These skulls were purchased by Mr. Baker, and are the originals of which casts are by his desire presented to the Academy, being duplicates of others given by him to the University Museum, where are now to be found, through the generosity of the Earl of Enniskillen, the East India Company, and our Zoological Society, a very instructive collection of the remains of bears, both fossil and recent.

On the discovery by Mr. Underwood of the larger skull, it was somewhat hastily announced as that of a great Irish wolf-dog, and was published in the newspapers as such. Under this impression, it was brought to Mr. Ball, who, without hesitation, pronounced it to be that of a bear, which, on a little further investigation, he considered to be the black bear of Europe. Soon after, Mr. Baker, with laudable liberality, purchased both specimens, and has thus preserved evidence of the existence of bears in Ireland, of which we had before no tangible proof or historical evidence. Dr. Scouler, in a paper on extinct animals of Ireland, published in the first volume of the Geological Journal, observes, that while bears still maintained their ground in England, they were unknown in Ireland. The venerable Bede states, the only ravenous animals of Ireland were the wolf and fox. Giraldus makes no mention of the bear, and St. Donatus, who died in 840, states it was not a native, "ursorum rabies nulla est ibi," &c.

The late Mr. Richardson, through whose kind interference Mr. Ball obtained leave to make moulds of the skulls, appears to have been in much doubt as to their nature. He states (in his History of Dogs, p. 36) his opinion, that "they are the remains of an extinct animal allied to, but by no means identical with the dog; and an animal with which we are now unacquainted, partaking somewhat of the characteristics of the bears, and perhaps, also, of the hyænas." Mr. Ball observed that the discrimination of skulls of bears presented zoological difficulties quite sufficient to account for the erroneous views which had been taken; the alterations of age in the occipital and sagittal crests, the dropping of the premolars, and, in some cases, of the incisor teeth, were quite sufficient to mislead, and had often misled naturalists; but the structure and arrangement of the molar teeth, and the peculiar depressed form of the bullæ tympanicæ, are unerring proofs of the ursidæ, at all times distinguishing them from dogs.

Mr. Ball then proceeded to remark, that if any evidence were wanted to prove that the skulls alluded to were Irish, he could supply it by producing a cast of a third specimen, form which he had been kindly allowed to take a mould for the University Museum by its owner, Mr. Cooke, of Parsonstown, the original had been found in Mr. Cooke's neighbourhood, as Mr. Ball understood, in deepening a river. He mentioned also that he had heard from the late Mr. John Robinson, of that locality, of the discovery and wanton destruction of skulls on his grounds, which were very possibly those of bears. It is probable that the bear and great Irish deer were involved in one common catastrophe, and perished together.

Mr. Ball stated, that being desirous of confirming the accuracy of his own views, he submitted casts of the skulls to the greatest living authority, merely stating that they were supposed to be Irish, and requesting an opinion as to their species. The following note is the reply to his questions:

"*College of Surgeons, London, Dec.* 7, 1849.

"MY DEAR BALL,—The casts of the fine crania of bear duly arrived, and I have been comparing them this morning.

They all differ from *Ursus spelæus* in the minor elevation of the forehead, and, what is more decisive, in the smaller relative sizes of the last molar, upper jaw; they also retain the first premolar. The largest of the three skulls presents a close correspondence of general form and of flatness of forehead with the largest of our old male skulls of *Ursus maritimus*, but the molars are relatively larger, especially the last, in the Irish skull; this is decisive against *Ursus maritimus.* I regret that I have no skull at command of a good old male *U. ferox.* A young female skull of that species indicates the proportions of the molars to be similar to those in the Irish specimens; but then the proportions of the teeth in question are likewise those of *Ursus arctos;* and the two smaller skulls from Ireland show an elevation of forehead which, though less than in *U. spelæus*, is greater than in any specimen or figure that I have seen of *U. ferox.* There remains, therefore, for comparison, the varieties of *Ursus arctos*, for the tropical Indian and Malayan bears have characteristics too well-marked and well-known to be dwelt on.

"The great black variety of the European *Ursus arctos* is that to which the Irish skulls offer the nearest resemblance. I can find no character in the casts of the skulls which you have sent that I could point to as a specific distinction; but then I must add, that I feel equal difficulty in laying down the specific distinction between the *Ursus priscus* of Goldfuss from Gailenreuth cavern, and the existing largest varieties of *Ursus arctos*, or the Irish bears. These specimens have much strengthened, if not quite confirmed, a growing suspicion that *U. priscus* is specifically identical with, and was the progenitor of, our European *U. arctos;* at the same time, they prove that *U. priscus* was not the mere female, as M. De Blainville believes, of *U. spelæus.* Your three specimens are all of the same species; the largest is the male, the smallest, with well-worn molars, the female. Now, the large male skull establishes the specific distinction of the equally large male *Ursus spelæus*, and consequen the specific, and not merely sexual, distinction of *U. prisc* but at the same time, the Irish crania show that the charac of the forehead alluded to in my 'British Fossil Mammal p. 83, is not constant, and not good for a specific differe with *Ursus arctos.* To conclude, then, as at present inform I should refer your Irish skulls to *Ursus arctos;* and the le degenerated representative of that species now living, v the great black bear, or very dark brown variety of the Sc dinavian wilds, is that which comes closest to the old I bears. Whether this respectable carnivore continued to e after the slaughter of the last megaceros will be shown by precise bed in which the specimens were found. I should to know the authority, if any, for their derivation, from p bog, and not from shell marl, if the case be so.

"Ever your's,

(Signed) "R. Owen."

Mr. Ball was of opinion, from examination of the origi bear skulls, that they were not in the peat, but in the m below it, where he believed all the heads of the megacer probably fifty, which he had closely inspected, were fou In no case was peat to be discovered in the cavities, while many marl was present. He expressed his gratification finding that his own views were supported by those Professor Owen, from whom, on this and other occasio he received kind aid. He also expressed obligations to Earl of Enniskillen, Mr. Baker, Mr. Cooke, and Mr. W ren; and concluded by moving the thanks of the Academy Mr. Abraham Whyte Baker, Sen., for his kindness in p senting casts of his valuable specimens to its museum of an quities.

Colonel H. D. Jones presented tables of the fall of ra with the levels of the Shannon and state of the wind, observ and recorded at Athlone, by John Long, Esq., during a period of four years.

The Tables (see Appendix, No. VI.) are compiled from *daily* observations. The columns are arranged to show, in monthly periods, the various fluctuations in the fall of rain, with the duration and variable nature of the dry and wet periods, also the greatest amount of continuous fall of rain, as well as the greatest daily fall, thus presenting an exact criterion of the humidity and variable nature of the climate. The rise and fall of the Shannon is also shewn, with its various fluctuations; also the fluctuations of the wind, and its continuance at the various points. A general abstract table for the whole is given, and an average struck for the four years. The daily observations from which these tables are compiled, having been taken in the central district of Ireland, where no similar observations appear to have been recorded, may perhaps be considered as giving them increased value. The district is remote from the influence of hills or mountains, and lies about central in the great flat limestone field of Ireland, extending from Dublin to Galway.

Colonel Jones suggested that the Council should draw up instructions for parties employed by the Board of Works, in different parts of Ireland; explaining what objects of scientific and antiquarian interest ought to be noticed and preserved by them.

He proposed to bring the subject before the Board of Works, in the hopes that their officers might be enabled to make meteorological observations of value, or to secure for the Museum of the Academy antiquities worthy of preservation.

Sir William Betham read a note from Mr. William F. Wakeman, relating to the remains of the market cross of Navan.

"85, *Lower Camden-street, Dublin,*
December 3, 1849.

"Sir,—Had I been aware of your intention to notice the stone which formed the subject of your interesting paper read before the Academy on Friday evening last, it would have given me great pleasure to have afforded you information relative to its history, and the circumstances which induced me to have it forwarded from Navan to Dublin. The stone, which appears to have formed a portion of the market cross of Navan, had been removed from its original place, wherever that was, and was used as a building stone in a comparatively modern wall connected with a miserable back lane, branching from the street called Trim Gate, Navan. Upon removing the stone from its position in the wall, for the purpose of drawing it, I found that it had formed a portion of the shaft of an old cross, and as the inscriptions upon its sides contained names of considerable historical interest, I begged the fragment from the owner of the wall in which it had been, and caused it to be removed to the rooms which I then occupied in Navan. I subsequently learned that two similar stones, which had evidently formed portions of the same cross were known to exist. They are used as supports for casks in a public house, in Trim Gate, Navan, and are sculptured and inscribed. I used every endeavour to be allowed to make drawings of them, and even offered to pay for any trouble caused in removing the casks, but was at first flatly, and at length insolently refused. Under these circumstances, and believing that, were I to leave the stone which I had already secured in Navan, it would be lost or broken up, or perhaps *thrown into the Blackwater*, as at least one monument of "the Novan" has been, I caused it to be removed to the Academy, as the best place for its preservation which I could think of.

"I remain, &c. &c.,
"W. F. Wakeman.

"*To Sir William Betham, Knight.*"

The Secretary read a paper by Thomas L. Cooke, Esq. of Parsonstown, on certain bronze relics found at Dowris, in the King's County, and exhibited to the Academy specimens and drawings of the various articles described.

"On the 30th of November, 1848, the Rev. Dr. Robinson read an essay to the Royal Irish Academy, on the subject of certain bronze antiques found in the King's County, and of which a portion is in the possession of that scientific nobleman the Earl of Rosse.

"In order to correct a few trifling mistakes and inadvertencies into which he has fallen, I have thought it right to place on record before the Academy some facts and circumstances I happen to be cognizant of, relative to the discovery of the bronze articles which formed the subject matter of Dr. Robinson's essay.

"At the time the relics in question were found, I was resident in Parsonstown, distant about five miles from the site of the discovery. Having a desire to preserve the antiquities of the country, I did not rest until I became possessed of several of the articles found, and I at the moment collected all the information I could procure respecting the place, and other particulars of the finding. What I then and since have learned, I have embodied in the present communication.

"Dr. Robinson has been inaccurately informed as to the time when the original discovery was made. It is much more than sixteen years since; and I have reason to believe that it is even nearer to twenty-five than to twenty years ago.

"Sixteen years have elapsed since the publication in the 'Dublin Penny Journal,' vol. i. p. 376, of a paper of mine, in the first sentence of which I mentioned that the things therein enumerated were found (then, 1833), *a few years since*, near Birr. I cannot now find any entry or memorandum to enable me to fix the precise time. There, however, exists no doubt that it is more than twenty years ago. I suppose it to be about twenty-five years. One of the men that found the relics is dead more than sixteen years. The inaccuracy of Dr. Robinson's informant as to the time of the discovery appears to be material in this inquiry, as affording an indication of the doubtful reliance to be placed on his memory in other and more interesting portions of the communication made by him.

"With regard to the place where the discovery was made, I must remark, that it was not, as Dr. Robinson was informed, at Dowris-*Heath*, nor probably within a mile of it. It is quite true that the antiques were found on part of the extensive townland of Dowris, the situation of the greater part of which has been correctly stated to be on sheet 30 of the Ordnance Maps of the King's County. The relics in question were accidentally dug up by two persons, one of whom, Edward Hennessy, now deceased, was at that time sportsman to Mr. Drought of Whigsborough. The other man is living yet. They were at the time trenching potatoes on that part of Whigsborough known by the name of Derreens, and which lies between Whigsborough paddock wall and the water known by the name of Lough Cowr.

"I have stated, that a person is yet living who was actually with Hennessy when the antiquities described in part by Dr. Robinson were found. A second person also still lives who was privy to their discovery. He accompanied me recently to the spot.

"Having thus noticed the time and the actual place of finding the antiquities, I must go rather diffusely into a description of the several articles which were then found. Dr. Robinson was much misled in being brought to believe that the bronze vessel, in the possession of the Earl of Rosse, and its contents, were the only things discovered. There was at least a horse-load of gold-coloured bronze antiquities, of a variety of forms, exhumed at the time. Many of them are now in my collection, and I made presents of several of them to other collectors.

"The Dowris relics which fell into my hands, and of which I have sent specimens or drawings to be exhibited to the Academy, are as follow :

"No. 1. The vessel marked A, when found, was, as it now is, of a dark dingy colour, apparently caused by smoke or a deposition of carbon. It bears the marks of having been long in use, and is patched and mended with rivets in different places. Wherever its murky coating is removed, the metal of which this vessel is composed appears to be of the same golden hue as the other utensils found. This vessel had handles to it, but they were broken off by the persons who found it. Part of one of these handles is now in it.

"No. 2. is a portion of another vessel, marked B. It appears also to have been much used. It is much cleaner than the vessel marked A. Both vessels (more particularly that marked A) are composed of very thin and flexible sheets of bronze, not thicker than strong writing paper, which, being too slight to bear ordinary usage upon the fire, were fortified around the lag or junction of the sides and bottom with shields or protecting pieces of a stronger scantling, and apparently coarser metal. These shields are furrowed to prevent their slipping, and were originally riveted on the respective vessels. The bottom and several inches in height of the respective sides of both the vessels, A and B, have been hammered out of one continuous piece.

"I may here observe that brazen vessels were formerly esteemed of such great value in Ireland as to be considered worthy of being given and accepted as a fit tribute and donation to and by Irish kings and princes. Accordingly we find that Cathaoir-Mor bequeathed to Mogh-Corb fifty copper cauldrons, with other articles, some of which were made of gold, and all reckoned of great value. We also read in the Book of Rights that a cauldron was to be given as tribute to the king of Cashel by the king of Teamhair Luachra.

"The golden colour of the Dowris vessels well suited them for presents to and from royalty; and the high va the material, in the estimation of the maker, is evidenc the thinness of the sheets of which they are formed.

"No. 3. A great number of gold-coloured skeynes, of bronze, were found at Derreens, but it is to be reg that the finders left scarcely one of them unbroken. specimens marked C, D, and E, are of this class. It be remarked here, that the metal of which these skeyn composed was not brittle, for the ends of that marked C bent together when it came into my possession, and I, wi breaking, straightened it. Some of these skeynes ha rivets remaining in the handles: and the wooden handl attached to one of them; but it in a short time crumble dust.

No. 4. The gold-coloured bronze arrow-heads, or, as suppose, razor blades, marked F. I had two more of One of them, represented of the true size in the drawir I gave away, but I know not what became of the third. blade figured in the drawing had two parallel ribs ru lengthwise on each side. I am not able to offer any op based on certainty as to the use of these instruments. specimen marked E 2 was sent to me by one of the or discoverers of the bronze vessels, since the greater port this paper was written. He informs me that it remained his house, and acquired the whitish colour in consequer one of his children having put it into the fire. The heat probably brought all the tin to the surface.

"No. 5. Gold-coloured gouges. I send for inspe one, marked H, and I had another which I gave away. Earl of Rosse has one of these.

"No. 6. The *unfinished* punch or instrument mark I had two more of these instruments of a similar shape. were finished and polished up. They all were of diff sizes.

"No. 7. Gold-coloured ornaments or terminations for

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mels of skeynes. I had two or three of these, but I cannot now find any of them. One specimen I remember to have given away. They were about an inch and a half in length, and somewhat of the form of a Norwegian boat or yawl. The drawing I represents both the shape and size of these.

"No. 8. The dagger or knife, with flat handle-socket, marked K. I had one of these which was more perfect in the blade than this specimen is. I gave it away. The knife or instrument marked K 2 was brought to me on Saturday, the 1st September, 1849, by the surviving finder, whose death, Dr. Robinson was led to believe, took place two years ago.

"No. 9. Gold-coloured bronze articles, of which I am ignorant of the use. They appear as if intended for feet to something. I possessed two or three of them, but I cannot now find one. I presented one of them, together with some others of the articles mentioned in this paper, to the Marquis of Normanby, when Lord Lieutenant of Ireland. He had them removed to England. They were all alike in size, and are correctly figured in the drawing L, which, being copied from a sketch made by me with a view to publication, while the originals were in my hands, I can vouch as a faithful representation, and as being of the same size with the originals.

"No. 10. A strap of gold-coloured bronze, ornamented with flutings, and having a small hole in the end of it, seemingly intended for the purpose of passing a thong through, in order to fasten it to something else. It resembles a mutilated portion of the chin-stay of a military headpiece.

"No. 11. Gold-coloured horns or trumpets. I have had in my possession many of these which were found at Dowris. Some of them had lateral mouth-pieces.

"I must, however, remark, that I never saw one of this form put together with rivets, as described by Dr. Robinson (Proceedings R. I. A., vol. iv. p. 239). Having minutely examined all the bronze horns in the Earl of Rosse's collection, I have no hesitation in asserting that not even a single one of them was united with rivets. Some of them present at a distant view, to a superficial observer, the appearance of having been riveted; but, on closer examination, such appearance turns out to be nothing more than a mere nail-head ornament running along the sides or around the wider aperture of the horn. It is quite clear that the entire horn was, with its nail-head ornaments, made at a single casting. I send for inspection two specimens of this description of ornamented horn, marked N and N 2, found at Dowris, and belonging to my own collection.

"To two of the horns in Lord Rosse's possession additions have been annexed, not by riveting, but by a more remarkable process, that which is technically termed 'burning.' This mode of uniting metals is, I believe, reckoned now of rather modern invention. It is effected by pouring melting metal at a glowing temperature upon the junction of the two pieces intended to be united, and by that means fusing the entire into one mass.

"No. 12. Gold-coloured pear and spherical-shaped crotals or bells. These form the subject of curious and interesting study. I send a specimen of the spherical-shaped (marked O) from my own collection, and would send some of the pear-shaped, but I am aware there are some of them already in the museum of the Royal Irish Academy.

"No. 13. A variety of gold-coloured celts of different sizes. Mr. Donovan, the able chemist, has kindly analysed one of these celts for me. He found it composed of copper, 85·232; tin, 13·112; lead, 1·142; sulphur, carbon, &c., 0.150; and loss, but partially accounted for, 0·642 in every 100. I would be guilty of an injustice did I not here return thanks to my scientific friend, Mr. Donovan, for the public service his labours in that analysis have rendered.

No. 14. Gold-coloured hatchets. One of these (marked S) was for some time immerged in a brassfounder's pickle before I heard of it. The pickle deprived it of the enamel, but it exhibits the natural golden hue of the metal; and is curious for the manner in which the handle must have been affixed to it. The broken hatchet (marked T) shows the fine edge this sort of metal was capable of receiving.

"No. 15. Gold-coloured spear-heads of various kinds, from the large war-spear to the small one used for hunting. Some of these are in my collection. I send the javelin-head, marked U, for inspection, although it was not found at Dowris, because it is remarkable as being barbed. I purchased this specimen some years ago, at an auction of the effects of the late Edmund Molony, of Clonoony Castle, in the King's County. The barbs render it, I believe, unique. They seem to have been affixed with white solder, but they undoubtedly are of the same metal with the remainder of the weapon. The monarch Crimthan, who died A. D. 79, is said to have brought to his palace at Howth, from a foreign expedition, a lance so contrived that a person wounded by it could not recover. The spear-head now exhibited appears well suited to effect an equally deadly result, for it is probable that the barbs would become detached, and remain in any wound inflicted by it.

"No. 16. Two *unfinished* globular bells. These were broken by the finders, for the purpose, as one of them informed me, of trying what was within it. These crotals are marked X and Y, and they furnish important evidence of the country in which all the articles found along with them were manufactured. These are also composed of the gold-coloured metal.

"No. 17. A number of small pieces of rub-stone, having convex, concave, and flat surfaces, to suit the form of the various implements to be polished and finished up with them. Some of these pieces, marked Z, Z 2, and Z 3, are exhibited.

"No. 18. Some of the waste gold-coloured metal which remained after the operation of casting. It is marked A a, and evidently fell in a state of fusion against the side of one of the

spherical-shaped crotals, of which it bears a concave impres
A portion of this waste metal, analysed by Mr. O'Sulli
gave copper, 88·924; tin, 11·066, traces of lead, iron, and si
and loss, 0·010 to 100 grains.

"No. 19. Some other things made of the gold-colo
metal were also found at Dowris at the same time with
already detailed. One of the men privy to the discover
cently told me that a sort of chopper was amongst the nu
of things found. The handle of it was about twelve in
long, and, as he described it, was of a piece with the
The whole instrument, he says, resembled a butcher's cle
but that there was a sort of arm which projected from the
of the head and had a ring in the end of it. I could not
what became of this antique. It is worthy of note, that i
representation of the death of Hugh de Lacy, carved on
of the compartments of the large stone cross at Durro
the King's County, the person by whose hand he fell ho
cleaver somewhat resembling that just described, but wit
the ring or connecting arm. The button sent was,
several of a similar sort, also found here. It seems
composed of a different quality of metal from most o
other articles discovered in this place.

"It is with great diffidence in my own slender sources
formation that I venture to dissent from any opinion expre
by the reverend and learned divine who has had the mer
formally bringing the circumstances connected with the fin
of the Dowris relics under the notice of the Royal Irish
demy. Nevertheless I cannot agree with him in thin
that these highly wrought and curious crotals could ever
been intended as appendages to sheep or oxen, for the pur
of announcing their 'locus in quo' in the dense forests w
then overspread the face of the country. These cro
with their numerous engrailed or fluted ornamental ri
were finished too elaborately for such a rude purpose; and
tal, such as that of which they are composed, was at

time too much prized to be employed in such a pastoral use. Besides this, the crotals were not sufficiently sonorous to be audible at a few yards' distance, even in a silent chamber. How, then, could they be heard at the most moderate distance in the open air, and in a country obstructed by forest trees, and thickly entangled underwood? He who takes the trouble to shake one of the pear-shaped crotals belonging to the Academy, or the spherical-shaped one from my collection, now exhibited, must admit their inutility as instruments of sound. Moreover, I believe that if the people of this island had in former times been in the habit of appending such bells to the necks of sheep or cattle, the bells would have been common; and thence arises the question, if they were so common, why is it that none of them have been found elsewhere than at Dowris? Why is it that such bells have never been discovered *sparsim*, or by separate specimens, but that all that have been hitherto found have been met with together, and along with a great variety of other articles? It must also be borne in mind, that, notwithstanding the numerous notices of tribute of sheep and cattle mentioned in almost every page of the Book of Rights, a solitary expression is not to be found which could lead to the belief that any sort of bells were appended to the subjects of such tribute. On the contrary, we must presume, that if bells had been so used, they would not have been omitted in the record; for, in some parts of the same book, brass chains are mentioned as being upon the necks of the animals sent in payment.

"I apprehend, that Dr. Robinson has, in strictness, inaccurately described the Dowris crotals as having loose *clappers*. They each merely contain a single and very small detached piece of metal, somewhat in the manner of a modern sheep-bell. But a modern sheep-bell emits a loud sound when compared with the feeble tinkling of these ancient crotals.

"The cause of tenuity of sound in the Dowris crotals is obvious. In the first place, they were formed of a rather soft and flexible metal, which, unlike to our modern bell- could be bent to a considerable extent without breakin addition to the defect just mentioned, was another, an haps a greater impediment to sonorousness, arising fro mode of construction. These Dowris crotals are very ficially formed as instruments for the propagation of They are either hollow pears or hollow spheres, withou aperture, saving (and that only in some few specimens small slits in opposite points, through which passed whereon the core was supported during the operation o ing. Even these small openings were intentionally and ca hammered, or otherwise closed in, after the core had be tracted. Some of the specimens which have the slits seem to be in that state solely in consequence of the ac tal breaking of the metal in the act of being hammered

"The foregoing reasons seem to prove that the D crotals never were intended for any use requiring the em of sound audible beyond a very narrow limit indeed. I reasonably be asked here, could an artificer, so skilful Dowris bronze founder, have been ignorant that crotal structed as his were could not yield a loud sound? It a to me to be next to impossible that he could have been s he must have formed them with some other view. I am, fore, induced to suppose these crotals were employed sol some religious ceremonies.

"Ledwich (Antiquities, p. 251) tells us that the crotal was used by the pagan Roman priests; and W (Memoirs of the Irish Bards, p. 93) says: 'Small bells, we mean, as were appended to the tunic of the Jewish priest, and afterwards employed by the Greeks and Ro for various religious purposes, but particularly to fri ghosts and demons from their temples, were undoubted troduced with Christianity into this kingdom.' I appre notwithstanding the respectable authority of Mr. W that it is assigning by far too modern a date to the use of in Ireland to couple it with the introduction of Christianity. Lucretius (lib. ii.) furnishes an instance of the use made of bell-cymbals by the Romans in their religious ceremonies. Virgil (Georg. iv.), and Juvenal (Sat. 6), 'Tot tintinnabula dicas pulsari,' refer to similar usage. Potter (Antiquities, vol. ii.) mentions that the ancient Greeks, at the moment of a dying person's soul separating from the body, beat brazen kettles to drive away evil spirits.

"While I suppose that the Dowris crotals have been manufactured for Druidic purposes, I am not ignorant that a learned and justly esteemed antiquary, to whose opinion the greatest deference is due, believes them to have been intended for suspension from the trappings of steeds employed in war. Such an opinion, deduced from ancient sculptures, seems to me to be strongly supported by a passage in the prophecy of Zacharias. The words of the prophet alluded to are: 'In that day there shall be upon the bells of the horses, holiness unto the Lord.' The word used in the original may mean either bells or bridles; and while the authorized version of the Church of England adopts the translation 'bells,' it places the word 'bridles' in a marginal note. The vulgate renders it more generally by 'quod super frenum equi est,' and the Rheims Roman Catholic English Bible adopts the term 'bridle.'

"Notwithstanding the silence of these crotals, they, nevertheless, might have been appended as ornaments to horse trappings, as were the still more dumb stones known by the name of *cruan*. These were attached to the bridles. In the Book of Rights (Income of Uladh) we meet

> Fichi srian, sreaṫach, sotal,
> do chruan. . . . .

The laborious and learned O'Donovan, to whom Irish literature is so much indebted, says, in a note to this passage, that 'Cruan was a stone of a red and yellow colour.' It was, in fact, a kind of cornelian or agate. I send for inspection some stones which were probably once affixed to bridles. They are marked R, and are from my own collection.

" Having now gone *seriatim* through the several bronze antiques found at Dowris, as far as they have come under my observation, I cannot avoid here expressing my total dissent from the hypothesis that they formed the stock in trade of a travelling Phœnician, or other itinerant foreign merchant, wandering from house to house, and offering these commodities for barter or for sale. If, for the sake of argument, we suppose such a peripatetic dealer to have inadvertently got himself entangled in a quagmire, how could such an accident have compelled him there to abandon his wares altogether? He, at all events, could have removed piecemeal to a firmer footing such portable articles as those found at Dowris. But another question here arises, namely, whether, in fact, any bog whatever existed at Dowris in the remote time when the relics were left there. It is probable, nay, almost certain there was not any bog there then.

" Dowris, as its name imports (Ꝺuḃꞃoꞅ, a dark, dense wood), was originally a thick and extensive forest, and although there is a bog there at present, it was not there many centuries ago. In many parts of Ireland traces of former cultivation, and even houses, have been discovered beneath the bogs. In a paper presented by Mr. King to the Royal Society, and published with Molyneux's Natural History of Ireland, the writer says: ' There are many bogs of late standing in Ireland. When O'Donnell and Tyrone came to the relief of Kingsale, they wasted the countrie, especially as they came through Conought, which, by the means of the Earl of Clanrickard, was generally loyal, and there is a great tract of ground, *now a bog, that was then plowed land*, and there remains the mansion house of my lord ——, in the midst of it.' The late Earl of Rosse (then Sir Laurence Parsons) observes: ' It is now, indeed, universally admitted that where those immense bogs extend at present there once were cultivated plains.' At Dowris the bog abounds in oak and other timber, prostrate beneath the peat. Some of it has the roots charred, which surely could not have been conveniently effected in a wet swamp. The fire must, therefore, have been applied before bog was there. Even in the memory of living persons, that part of Dowris called Derreens, and on which the bronze treasure was found, was covered with copse and underwood.

"Abandoning all theory and speculation bearing on the rapid growth of bog, the fact must be recorded that the Dowris relics were not found in what can be properly denominated bog, but in the centre of a potato garden extending down the slope of a rising ground between the paddock and the moorland. A cock of hay has been left during the last winter between the place of the finding and the bog, so little of wet or quagmire exists there even now.

"One of the reasons assigned for supposing the Dowris antiquities to have been derelict by some travelling foreign merchant, is based on an opinion that Ireland formerly did not produce tin, which metal is said to have entered largely into the composition of ancient bronzes, and certainly was a component part of the articles found at Dowris. Dr. Robinson assures us that he analysed a great variety of bronzes, with such uniform results, that he supposed the identity of composition was evidence of their having all come from the same manufacturers. He, however, states that he afterwards found the peculiar properties of the atomic compound, viz., of 14 equivalents of copper, and one of tin, or nearly 88 of copper to 12 of tin by weight, were sufficiently distinct to make any metallurgist engaged in such a manufacture select it. But it appears that tin did not always enter into the composition of ancient weapons, and that, even when it did, the quantity varied. Thus, M. Hielm found a bronze dagger* to consist of $83\frac{7}{8}$ copper and $16\frac{1}{8}$ tin. An antique sword, found in 1779, in the peat moss of the Somme,* consisted of copper 87·47, and tin 12·53. Of three antique swords† found in the environs of Abbeville, one was found to consist of 85 of copper to 15 of tin; another of 90 of copper to 10 of tin; and the third of 96 of copper to 4 of tin. A fragment of an ancient scythe gave on analysis 92·6 copper, and 7·4 tin. Governor Pownal says, that the swords found at Cannæ, and those found in the bog of Femor in the county of Tipperary, consisted of a mixture of copper, iron, and some zinc.‡ Parkinson's Memoranda Chemica, p. 82, informs us, that 'Dr. Pearson, having examined some ancient metallic arms and utensils, was able to ascertain that they consisted of copper and tin, in the proportion of from *six to twelve* parts of copper to *one* of tin, according to the use for which they were intended.' Dr. Pearson's paper is in the Philosophical Transactions. The bronze springs for the balistæ, according to Philo of Byzantium, were made of copper 97, tin 3. The specimen of hasta magna, or more probably of a weapon for affixing to the axle of a war chariot, marked B 2, and sent for inspection, is of pure copper, without any admixture of alloy whatever, as are also the hatchets, marked C 2 and C 3. Whoever takes the trouble to look through a promiscuous collection of bronze antiques, will perceive, from the variety of colours, that no certain standard of composition has been adhered to. The golden colour of the Dowris bronzes is almost sufficient to distinguish them from all others; and even these differ amongst themselves; for, according to Mr. Donovan, the celt contains about 13½ of tin to 83⅓ of copper, with 1½ of lead, and some sulphur and carbon; while the waste metal subjected to Mr. O'Sullivan contained only 11 of tin to 89 of copper, with a mere trace of lead, iron, and silver.

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* Dictionary of Chemistry, by Andrew Ure, M.D. (title 'Copper').

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* Dictionary of Arts, &c., by Andrew Ure, M.D.

† Ibid.

‡ Account of some Irish antiquities read before the English Antiquarian Society. Feb. 10, 1774.

"It probably has been too hastily assumed, that tin was not found formerly in Ireland. The late Earl of Rosse* has argued, that Ireland has at least as good a title to rank under the name of Cassiterides, or Tin Islands, as Britain has. Nennius, no recent authority, bears his testimony, that a mine of tin formerly existed at Killarney. His words are: 'Est ibi stagnum quod vocatur Loch Lein quatuor circulis ambitur. Primo circulo gronna stanni ambitur, secundo circulo gronna plumbi, tertio circulo gronna ferri, quarto circulo gronna æris ambitur.' Smith† says he found, near the Lake of Killarney, an ore which contained tin. The following passage from Adrianus or Hadrianus Junius, known as Adrian, or Junius the Dutchman, shows that he, too, believed Ireland possessed mines of tin. That writer personifies Hibernia as saying:

> 'En ego cum regni sceptro mavortia bello
> Pectora et horriferas hominum, nil fingo, figuras,
> Qui cursu alipedes norint prævertere cervos,
> Dedico, piscosque lacus, volucrumque paludes
> Omnigenûm lustris fætâs, *stannique fodinas*,
> Et puri argenti venas, quas terra refossis
> Visceribus manes imos visura recludit.'

Even Camden,‡ whom O'Flaherty calls 'Cæcus Hibernigenis,' on account of his hostility to this nation, thought these verses worthy of his insertion, and he styles their author 'litteratissimus Adrianus Junius.' Camden, therefore, adds his sanction to the Dutchman's statement. Macgeoghegan,§ writing on the natural history of the country, has: 'Ou y trouve aussi des mines de mercure, *d'etain*,' &c., for which he quotes Peter Lombard, c. 9. The same writer says elsewhere: 'Ayant découvert chez eux de mines d'or, d'argent, d'etain, de plomb, et de fers, ils avoient appris à les fondre et à les fabriquer.' We have it also on the modern authority of Sir Robert Kane,* that tin-stone, which I believe consists of 95 parts of oxide of tin, and 5 parts of oxide of iron, is found disseminated through the auriferous soil of the county of Wicklow in our own day.

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* Defence of the Ancient History of Ireland.

† History of Kerry, p. 125.

‡ Latin edition, London, A.D. 1600.

§ Hist. d'Irlande, tom. i. c. 1.

Why, then, should it be supposed, in opposition to the authority of ancient writers, backed by tradition, that tin has not been formerly found in Ireland? Why suppose, contrary to the result of modern observation, that tin-stone does not exist in the county of Wicklow in this our own day?

"If it be admitted for argument sake that tin invariably enters into the composition of Irish bronzes, and that no tin mine was anciently known or worked in this island, surely such an admission by no means involves a concession that there was not plenty of that metal in this country in remote times. What was there to prevent a people, accustomed from such early times to making distant voyages, from visiting the neighbouring coast of Cornwall, the site of the stannaries, and importing plenty of tin from thence? In fact, Cornwall, stretching, as it does, into the junction of the Irish and British Channels, must have often interrupted their naval excursions, and attracted their attention, whether they would or not.

"It seems to me that there exists but little cause for hesitating to conclude that the various bronze articles found at Dowris were not left there by a Phœnician, or other itinerant merchant. There are cogent reasons for believing that these interesting antiques were manufactured on the spot by some metallurgist who established his foundry there. Accordingly we observe amongst the things discovered three vessels, some of which bear the marks of having been used, old, worn, and repeatedly repaired. We observe also some of the spherical-shaped crotals, and some other articles in the rough state after being cast. The unfinished bells sent for inspection, and marked X and Y, yet contain a portion of the core, which renders unnecessary any conjecture as to the substance such core was composed of. It seems to have been a composition of tough clay and sand. The amorphous lump of metal, marked A a, also bears testimony that the place where it was found was the workshop of a manufacturer. What travelling merchant would encumber himself by carrying about with him the residue of the contents of the crucible? If we suppose him to have done so, we must at the same instant admit that he carried it for sale to some person capable of forming it into some more useful shape.

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* Industrial Resources of Ireland.

"I must not here omit noticing the rub-stones which were found. They, too, point out that the whole belonged to a resident operative rather than to an itinerant merchant. In fine, the great quantity of things found, their variety, their being in an unfinished as well as in a finished state, the amorphous mass of spare metal, and the rub-stones, all tend to the conclusion that Dowris was the site of a manufactory of bronze utensils. A farther and remarkable proof of the existence of a foundry where these relics were found is added by the luxuriance of the vegetable matter on the spot. When the field was first shown to me, I, without further information, led those that accompanied me to the particular part of it. I was right in my conjecture, which was confirmed by the man already written of, who was privy to the finding. Charcoal must have been much used in combining the copper with zinc or tin; and carbon being an ingredient entering largely into the composition of vegetables, and also serving as a stimulant to their growth, the grass and weeds on the site of the foundry were marked by a vegetation exceeding in rankness that on any other part of the field.

"The golden colour of the Dowris bronze is very remarkable. The ancient Romans were acquainted with a kind of brass, which, from its great resemblance to gold in colour, they denominated orichalch, or orichalcum. Some say this alloy, which had copper for its basis, was made by throwing cadmium or calamine on the copper which absorbed it. Others suppose there was an original natural ore of orichalcum. Be this as it may, it is certain that the Greeks, too, were acquainted with a metallic substance called orichalcum, even before Rome was founded. When Julius Cæsar plundered the capitol of a large quantity of gold, he replaced it with orichalcum, to deceive the people; and Vitellius resorted to a similar expedient when he despoiled the temples of their ornaments.

" In whatever manner the golden hue was originally given to the Dowris alloy, there is little doubt but that the colour on the exterior of the bronzes has been mellowed by their having long lain buried in the ground. Time and the effect of the soil have produced a varnish defying modern imitation."

JANUARY 14TH, 1850.

REV. HUMPHREY LLOYD, D. D., PRESIDENT, in the Chair.

CHARLES GEORGE FAIRFIELD, Esq.; Chichester Samuel Fortescue, Esq., M. P.; Charles Fox, Esq.; Alexander Gordon Melville, M. D.; Christopher Moore, Esq.; and Wellington A. Purdon, Esq.; were elected Members of the Academy.

The Secretary, for James Westby, Esq., of High Park, exhibited an ancient model in wood, of a sword, found at Ballykillmurry, county Wicklow, and communicated the following notice of its discovery, drawn up by that gentleman.

The following is the statement of John Keough, of Ballykillmurry, county Wicklow, in the employment of William Jones Westby, Esq., of High Park:

"About eight years past I and my son were cutting turf on Ballykillmurry bog; about five perches from the dry ground in the bog, and five feet from the surface, and about five more from the gravel, we found the accompanying sword. The bog had never been cut before; at least it had all the appearance of being in its original state. About eight yards from the sword, and three feet deep, we found a vessel of wood, filled with what we considered suet; it was in a perfectly mouldy state, as also the vessel, which fell to pieces when we took it up. The suet, to the best of my opinion, had never been rendered or boiled. The vessel was about the size of a small cool, made of staves, and had two iron hoops on it."

The Secretary read a letter from Richard Caulfield, Esq., of Cork, containing an account of the discovery of a chamber in Killeens Fort, situated two miles north of Cork.

"*Sunday's Well, Cork, Jan.* 12, 1850.

"Rev. dear Sir,—During one of my late explorations I happened to meet with an ancient stone head amid the rubbish of the south wall of Cloghphillip Castle, which fell down about a year and a half since, not, I am sure, without some cause, for this is not the only wall of a castle that has come under my notice, endangered by persons digging for gold; which, when they dream of (as they say), nothing will prevent them from examining the favoured spot, and often undermining the wall.

"Cloghphillip Castle (it is marked on the map of Muskrye in the Pac. Hib.) stands on a very high eminence about one mile N. W. of Blarney Castle in this county, and commanding a very extensive view of the country all round. It must have been used to great advantage as a signal tower, when Blarney Castle and others in this part of the county were defended, as, from its situation, Blarney commands no view. It was built by the M'Carthys, as well as Blarney, Kilcrea, and Macroom. As Kilcrea Castle can be seen from the top of Cloghphillip, a very ready mode of telegraphing may have been used in those days with Macroom, and thence with all the west of the County Cork. The difficulty of approaching Macroom in those times (which must have been a journey from Cork of near two days) may be conjectured from the account in the Pac. Hib. vol. ii. p. 602. How it obtained the cognomen 'Phillip,' I am unable to account, nor could I obtain any tradition relative to it from the oldest inhabitants of the locality. There is a stone in the north-east angle of the castle, with this inscription, 'D. C. K. 1590.' I have a rubbing of this stone. The nose of the head was mutilated in the fall; otherwise it is in fair condition. The forehead is encircled with a band composed of lozenges, a peruke covers the ears, and seems to have been formed by interweaving tresses. The mouth is open. On the whole, the appearance of the face is curious, though rude. There is a shank at the back by which it was inserted in the wall, but, singular enough, its existence was unknown until the wall fell down. If you think it would be worth the acceptance of the Royal Irish Academy, I will feel great pleasure in sending it up to you with the rubbing. A circumstance not unworthy of mention, as it tended to excite the prejudices of the country people, tended also to increase the difficulty I had in obtaining the head. The day after it was discovered, the person who found it inserted it in the pier of an old gate which separates the castle from a farmyard. On that evening, as the herdsman was returning home through this gate in charge of a bull, the animal, noticing the head, immediately took fright. His keeper, in endeavouring to restrain him, was so goaded by the infuriated animal that he died on the following day. Some pigs were also killed by the falling of the wall, and all this was supposed to have occurred through the agency of the insulted genius of the castle. Thus the removal of the head was thought likely to be succeeded by a more disastrous course of events; but fortunately nothing since has occurred of such a nature, as indeed I ventured to promise. I may here remark, that the stone of which the head is composed is found in blocks under the foundation of the castle, but nowhere else in the vicinity.

"I have been for most of the last week engaged in opening the Killeens Fort, situated about two miles north of this city. For two days our men were unsuccessful, but on the third I found out the crypt. I would recommend all my friends, when they go to explore a fort, at first to sound (if the entrance is not visible) with a long iron crowbar in different parts of it. Supposing a line drawn from east to west dividing the fort, let a strong workman be employed at each side of it. If this principle be adopted the flags will in most cases be certainly met with. If the ceiling of the cave be formed of earth the bar will disappear. Many a time I fervently wished that it would. I enclose a sketch showing the position of the cave, and a section of the cave of the fort, as far as I have discovered. The flags of the ceiling are of an enormous size, and are supported by huge blocks of stone, some of limestone (which is not found in this part of the country). But I regret to say that I have as yet discovered no inscription in this fort, which is the chief reason why I have opened so many of these places. However, when we have removed all the rubbish and clay with which the place is partly filled, I may be more fortunate. My great object is to examine all the forts for some miles round Cork. Although the work proceeds slowly, yet the investigation is accurate; but I assure you many difficulties present themselves during these operations when least expected. We have preludes, and addresses), appears to have been not only the MENALCAS[*] of the Spenser's Shepherd's Calendar, who had "under-fonged" the faithless Rosalinde, but also the HOLOFERNES, and DON ADRIANO DE ARMADO of Shakespeare's more laughable satire, in his Love's Labour Lost.

Having thus identified *Rose Daniel* with *Rosalinde*, and *Rosalinde* with *Mirabella*, by means of their respective union with the same person identified as *John Florio* (or the Resolute), *Menalcas* in the Shepherd's Calender, and the *Carl Disdain* in the Faerie Queen, Mr. Halpin proceeds to sum up the results of Spenser's first disappointed passion in the following words:

"Whatever happiness poor Rose Daniel may have enjoyed in the domestic virtues and real talents of such a husband as Florio, it is certain that, if she were a sensible and sensitive woman, she must have experienced great pain and annoyance from the ridicule and hostility to which his pride, petulance, and ill-temper constantly exposed him in public. In this respect her sufferings seem to have fed the vengeance of her discarded, but unforgiving and ungenerous suitor. But she may have had her consolations, too. Florio was highly esteemed by the nobility of Elizabeth's days, and was favoured in the Court of James I. That he was an attached and affectionate husband, his last will and testament gives ample and touching evidence (*see "New Illustrations of Shakespeare, by the Rev. Joseph Hunter*, vol. ii. p. 280)."

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[*] This name is, from its Greek derivation, homonymous with "the Resolute." It need hardly be observed that it is derived from *μενος* and *αλκη*, both signifying modifications of force, mental or bodily. They are repeatedly used together as equivalents, thus, *μενεος δ'αλκης τε λαθωμαι*. Il. z. 265. In Liddel and Scott's edition of Passow's Greek-English Lexicon, *μενος* in composition is said to "bear always a collateral notion of *resolve* and firmness:" and here we have the very notion expressed by the very word we want. MENALCAS is, therefore, the appropriate and expressive *nom de guerre* of the RESOLUTE.

In the second branch of his essay, Mr. Halpin treats of the name and family of

SPENSER'S WIFE,

or the Irish lady to whom, as appears from the most beautiful and spirited of all hymeneal songs, the *Epithalamion*, he was ultimately married. Further than that her Christian name (as revealed by the poet) was Elizabeth, the biographers are at a stand still. Without an exception, they all coincide in the obvious error that she was "a person of inferior rank,—a country lass;" but, in Mr. Halpin's opinion, she was no more "a country lass," in the ordinary sense of the terms, than Spenser himself,—late Secretary to the Lord Lieutenant, and even then, Clerk of the Council of Munster,—was "a shepherd's boy." Had the biographers even slightly consulted that portion of the poet's works expressly written to record his passion, the *Amoretti*, they would have found she was "a lady" whose rank was rather "disparaged" than exalted by her "sorting" with him; that she was a person of good birth and station, well educated, accomplished in the arts of design and embroidery (accomplishments not usually found in an Irish peasant's daughter), enjoying the respect, the elegancies, if not the luxuries, of her condition, and resident in the poet's own neighbourhood; in whose house (or her father's) the poet himself was no unfrequent visitor. (See *Sonnets*, *passim*). In fact, her family mansion must evidently have lain on the banks of the Mulla Water, Spenser's favourite stream, a tributary of the Black Water, somewhere between Kilcolman Castle and the prosperous sea-port of Youghal, but considerably nearer to the former. This brings our inquiries within narrow limits, namely, the range bordering on the Mulla. But Spenser had expressly promised the lady, in three several sonnets (see Son. 73, 75, and 82) to *eternize her name*, and we have no right to doubt but that he fulfilled his engagement. If, then, we assume him to have proceeded, as in the case of his former mistress, recording his passion, but concealing its ob- ject, by means of the anagram; and if we can fix upon any di- tinctive epithet, common to the several poems celebrating h person, and solvable into the name of a person whose resi and circumstances correspond with those ascribed to her b her worshipper, we obtain a distinct clue to the long-k secret.

In the *Amoretti*, the *Epithalamion*, and the *Colin Clo Come Home Again*, we find the object of the poet's most p sionate cares distinctively and energetically, with all the e phasis of Italic letters and Capital initials (in all the origi editions at least), addressed or spoken of as "an *Angel*," of one

> Divinely wrought,
> And of the *brood of Angels* heavenly born,
> And with the *crew of blessed saints* up brought,

in no less than thirteen or fourteen remarkable passages.

But the perpetual recurrence to the same epithet would b too trite and common-place for the invention, or the rich v cabulary, of such a poet as Spenser, if "no more were me than meets the eye;" and probably the reader anticipates, b this time, that the true name concealed under this anagram i NAGLE, or (as in a subsequent sonnet—lxxiv.—we are i formed of her christian name) *Elizabeth Nagle*.

What seems to confirm this conjecture almost into a ce tainty is, that in the immediate neighbourhood of Kilc man there resided a family whose name and circumstan correspond precisely with those which have now been elici from the poems written by Spenser on the occasion of h courtship and marriage. The *Nagles* or *Nangles* were a ve ancient sept in the counties of Cork and Waterford. The were two races of them, distinguished by the colour of the hair into the *Red* and the *Black*. Of the former, the chief or hea resided at *Moneannymy*, an ancient preceptory of the Knigh of St. John, beautifully seated on the banks of the Mulla, and at a convenient distance for frequent visits from Kilcolman; and of this family Elizabeth was most probably a member, the colour of her hair corresponding with their's, and resembling "a golden mantle." (See Son. lxxxi. and Epithal. st. 9). The family name is assumed by Heralds to be derived *ab Angulo*, as *Hugo ab Angulo*, an ancestor of the Nagles or Nangles; but Spenser seems to have drawn it (according to a precedent of his own in the Faerie Queen, see book iii. canto iii. stan. 54, 55), more poetically *de Angelis*, when he describes Elizabeth as "of the *brood* of ANGELS heavenly born."

It is no objection to this view that Spenser's eldest son, Sylvanus, was subsequently married to a Miss Ellen Nagle of the same family; for the intermarriage of first cousins is no unusual occurrence; and Miss Ellen Nagle was the daughter of David Nagle, who was, in all probability, the brother of the Elizabeth Nagle whom we suppose to have been married to Edmund Spenser. The circumstances of the country, too, at the time of Sylvanus Spenser's marriage, were likely to circumscribe the choice of a young man, in the selection of a wife, within very narrow limits.

It only remains to be here remarked, that, after Edmund Spenser's death, his widow was married again to a person named Roger Seckerstone, or Seggerston. (See Appendix to CRAIK'S SPENSER in *Knight's* Weekly Volumes, vol. iii. p. 243). The author of this essay, however, has been unable to trace her out. He is informed that a family of that name still resides in one of the southern counties, either Cork or Kerry. It is not improbable that these pages may meet the eye of some one able to trace out the history of the lady in question, and thus either to confirm or to dissipate the conjecture in which Mr. Halpin has indulged. The point is well worthy the antiquarian's research.

JANUARY 28TH, 1840.

JOHN ANSTER, LL.D., VICE-PRESIDENT, in the Chair.

PROFESSOR JELLETT read the following Abstract of a Paper on the Equilibrium or Motion of a Molecular System.

The object of the present paper is to deduce, on the most general theory of molecular action, the equations of equilibrium or motion of a body, solid or fluid, whose several particles have been displaced from their position of equilibrium.

The action of any one particle or molecule of a body upon another will in general depend on the *state* of the two molecules, on their *primitive positions*, and on their *displaced positions*. If it be supposed that the state of a particle, that is to say, its capacity of exerting force, is not altered by the displacement of the surrounding particles, it is plain that the force developed by the displacement of two molecules will be of the form

$$f(x, y, z, x', y', z', \xi, \eta, \zeta, \xi', \eta', \zeta',),$$

where x, y, z are the co-ordinates, and ξ, η, ζ the resolved displacements of the first particle; x', y', z', ξ', η', ζ', having the same signification for the second. The hypothesis here made may be termed the *hypothesis of independent action.*

Adopting this hypothesis, and modifying the foregoing expression by the observation that no molecular force is developed by a mere *translation* of the entire system from one position to another, the value of the force will be

$$F_0 + A(\xi' - \xi) + B(\eta' - \eta) + C(\zeta' - \zeta),$$

F_0, A, B, C being of the form

$$f(x, y, z, x', y', z'),$$

or

$$f(x, y, z, \rho, \theta, \phi),$$

where ρ, θ, ϕ are the polar co-ordinates of the second particle with regard to the first.

The tendency of this force will evidently be to change the *relative* position of the two molecules. From these principles the author has deduced, by the method of Lagrange, the equations of equilibrium or motion of any body, homogeneous or heterogeneous, whose particles satisfy the hypothesis of independent action. These are, in general, partial differential equations of the second order. If the body be homogeneous, the coefficients in these equations will become constant, and the differential coefficients of the first order will disappear.

The author finds that in the case of a homogeneous solid the number of distinct coefficients which these equations contain will be fifty-four, namely, eighteen for each equation. The equations of motion are in this case of the form

$$\begin{aligned}\frac{d^2\xi}{dt^2} = A_1 \frac{d^2\xi}{dx^2} + B_1 \frac{d^2\xi}{dy^2} + C_1 \frac{d^2\xi}{dz^2}, \\ + A_2 \frac{d^2\eta}{dx^2} + \&c. \\ + A_3 \frac{d^2\zeta}{dx^2} + \&c. \\ + 2D_1 \frac{d^2\xi}{dydz} + \&c. + 2E_1 \frac{d^2\eta}{dydz} + \&c. + 2F_1 \frac{d^2\zeta}{dydz} + \&c. \\ \frac{d^2\eta}{dt^2} = \&c. \frac{d^2\zeta}{dt^2} = \&c.\end{aligned}$$

The coefficients A_1, B_1, &c. being all independent, their number will plainly be as above stated.

The author has integrated these equations for the case of plane waves and rectilinear vibrations. He finds that for each direction of wave plane there are three directions of vibration. These directions are not, however, at right angles, nor are they necessarily all real.

The author has next proceeded to examine the hypothesis that the internal moments of the system may be represented by the variation of a single function V. He finds that in this case the number of constants in the equations of motion will be reduced to thirty-six. This agrees with the result obtained by Mr. Haughton.

The author has also obtained this important result:

If V be a quadratic function of the nine quantities,

$$\frac{d\xi}{dx}, \frac{d\xi}{dy}, \frac{d\xi}{dz}, \frac{d\eta}{dx}, \frac{d\eta}{dy}, \frac{d\eta}{dz}, \frac{d\zeta}{dx}, \frac{d\zeta}{dy}, \frac{d\zeta}{dz},$$

such that the internal moments of a system or body whose particles act independently may be represented by

$$\iiint \delta V dxdydz,$$

that part of the function which involves the products,

$$\frac{d\xi}{dx} \cdot \frac{d\eta}{dy}, \frac{d\xi}{dx} \cdot \frac{d\zeta}{dy}, \text{ \&c.,}$$

must be of the form

$$L \left(\frac{d\xi}{dx} \frac{d\eta}{dy} + \frac{d\xi}{dy} \frac{d\eta}{dx} \right) + M \left(\frac{d\xi}{dx} \frac{d\zeta}{dy} + \frac{d\xi}{dy} \frac{d\zeta}{dx} \right) + \text{\&c.}$$

It is plain, then, that the coefficients of the several terms in V are not independent of one another, and cannot therefore be arbitrarily assumed. In fact there are among these coefficients nine equations of condition, whose existence is a necessary consequence of the hypothesis of independent action. Now neither the function used by Professor Mac Cullagh, nor that used by Mr. Green, satisfy these conditions. The author infers, therefore, that in media such as these writers suppose the ether to be, the *state* of each particle, i. e. its absolute power of producing motion in another particle, is changed by the displacement of the surrounding particles.

The author has then proceeded to investigate the equations of motion on this more extended supposition. He finds that in the general case the form of these equations is not altered, and that the number of the constants remains the same. But if it be supposed that the internal moments are represented by the variation of a single function V, the present supposition differs from the hypothesis of independent action, in the absence of any restriction upon the form of V, whose coefficients are now perfectly arbitrary, and may, therefore, be assumed to satisfy at pleasure any given relations.

The Rev. Samuel Haughton communicated the following Abstract of a new Method of deducing Fresnel's Laws of Wave Propagation from a mechanical Theory.

In a memoir on a classification of elastic media, presented to this Academy in January, 1849, I deduced the general equations of motion resulting from the hypothesis, that the function on which they depend is a function of the nine differential coefficients of the displacements of each molecule. In that memoir I have also shown the possibility of the laws of wave propagation being the same in media of different molecular constitutions, and have given some examples in the theories of Light. The general function V used in that paper contains *forty-five* coefficients, and may be represented thus:

$$2V = \Sigma(\alpha_1^2) + 2\Sigma(\alpha_1\beta_1) + 2\Sigma(\alpha_2\alpha_3) + 2\Sigma(\alpha_1\beta_2), \qquad (1)$$

adopting the notation used in the memoir. The last term of this equation consists of *eighteen* terms, while each of the others contains *nine*. Among other hypotheses made by me at the time of writing the memoir, I assumed the coefficients of this last term to be equal in pairs, so as to reduce the total number of coefficients to thirty-six. The consequences which I deduced from this hypothesis were interesting, but I did not publish them in my memoir, as I could give no satisfactory reason for the hypothesis itself. As I conceived it at the time, it was only a mathematical assumption made to simplify my equations. Some days since, my friend Professor Jellett communicated to me a result at which he has lately arrived, and on referring to my note book I found that Mr. Jellett's theorem gave a *physical* reason for the hypothesis I have alluded to. So far as Mr. Jellett's investigation relates to this subject, it may be thus stated:

"'If in a system of molecules the forces developed by the displacement of any two molecules be functions of *their relative* displacements only, and tend to restore them to their original positions; the function V for such a system will contain thirty-six coefficients, the coefficients of $\Sigma(\alpha_1\beta_2)$ being equal in pairs.'

"This theorem evidently supplies the link which was wanting in my equations, which, perhaps, may not now be deemed unworthy of notice, as they may be shown to rest on a definite physical hypothesis.

"The note from which the following abstract is taken is dated December 26, 1848. I have slightly altered the notation, and prefixed two theorems which facilitate the understanding of what follows.

Theorem I.

"Let $(u_1, u_2, \text{\&c.})$ be functions of (x, y, z), defined by the following equations:

$$\begin{array}{lll} u_1 = \beta_2\gamma_3 - \beta_3\gamma_2 & v_1 = \gamma_2\alpha_3 - \gamma_3\alpha_2 & w_1 = \alpha_2\beta_3 - \alpha_3\beta_2 \\ u_2 = \beta_3\gamma_1 - \beta_1\gamma_3 & v_2 = \gamma_3\alpha_1 - \gamma_1\alpha_3 & w_2 = \alpha_3\beta_1 - \alpha_1\beta_3 \\ u_3 = \beta_1\gamma_2 - \beta_2\gamma_1 & v_3 = \gamma_1\alpha_2 - \gamma_2\alpha_1 & w_3 = \alpha_1\beta_2 - \alpha_2\beta_1 \end{array}$$

$(\alpha_1, \alpha_2, \beta_1, \text{\&c.})$ denoting $\left(\frac{d\xi}{dx}, \frac{d\xi}{dy}, \frac{d\eta}{dx}, \text{\&c.}\right)$

"If the co-ordinates be changed into x', y', z', by changing the direction, without changing the origin, then the functions $(u_1,\ v_2,\ w_3,\ v_3 + w_2,\ w_1 + u_3,\ u_2 + v_1)$ will reproduce themselves by means of the following equations:

$$\left.\begin{aligned}
u_1 &= a^2u'_1 + b^2v'_2 + c^2w'_3 + bc\,(v'_3 + w'_2) + ac\,(w'_1 + u'_3) \\
&\qquad + ab\,(u'_2 + v'_1) \\
v_2 &= a'^2u'_1 + b'^2v'_2 + c'^2w'_3 + b'c'\,(v'_3 + w'_2) + a'c'\,(w'_1 + u'_3) \\
&\qquad + a'b'\,(u'_2 + v'_1) \\
w_3 &= a''^2u'_1 + b''^2v'_2 + c''^2w'_3 + b''c''\,(v'_3 + w'_2) \\
&\qquad + a''c''\,(w'_1 + u'_3) + a''b''\,(u'_2 + v'_1) \\
v_3 + w_2 &= 2a'a''u'_1 + 2b'b''v'_2 + 2c'c''w'_3 + (b'c'' + b''c')\,(v'_3 + w'_2) \\
&\qquad + (c'a'' + c''a')\,(w'_1 + u'_3) + (a'b'' + a''b')\,(u'_2 + v'_1) \\
w_1 + u_3 &= 2aa''u'_1 + 2bb''v'_2 + 2cc''w'_3 + (b''c + bc'')\,(v'_3 + w'_2) + \\
&\qquad (c''a + ca'')\,(w'_1 + u'_3) + (a''b + ab'')\,(u'_2 + v'_1) \\
u_2 + v_1 &= 2aa'u'_1 + 2bb'v'_2 + 2cc'w'_3 + (bc' + b'c)\,(v'_3 + w'_2) + \\
&\qquad (ca' + c'a)\,(w'_1 + u'_3) + (ab' + a'b)\,(u'_2 + v'_1).
\end{aligned}\right\}\ (2)$$

These equations of transformation are identical with those for the transformation of x^2, y^2, z^2, $2yz$, $2xz$, $2xy$.

Theorem II.

" Let λ, μ, ν, ϕ, χ, ψ be functions defined by the following equations :

$$\begin{aligned}
\lambda &= \alpha_1^2 + \beta_1^2 + \gamma_1^2 & \phi &= \alpha_2\alpha_3 + \beta_2\beta_3 + \gamma_2\gamma_3 \\
\mu &= \alpha_2^2 + \beta_2^2 + \gamma_2^2 & \chi &= \alpha_3\alpha_1 + \beta_3\beta_1 + \gamma_3\gamma_1 \\
\nu &= \alpha_3^2 + \beta_3^2 + \gamma_3^2 & \psi &= \alpha_1\alpha_2 + \beta_1\beta_2 + \gamma_1\gamma_2
\end{aligned}$$

These functions will be changed, by a change of co-ordinates, into the following linear functions of similar quantities :

$$\left.\begin{aligned}
\lambda &= a^2\lambda' + b^2\mu' + c^2\nu' + 2bc\,\phi' + 2ca\chi' + 2ab\psi' \\
\lambda &= a'^2\lambda' + b'^2\mu' + c'^2\nu' + 2b'c'\phi' + 2c'a'\chi' = 2a'b'\psi' \\
\nu &= a''^2\lambda' + b''^2\mu' + c''^2\nu' + 2b''c''\phi' + 2c''a''\chi' + 2a''b''\psi' \\
\phi &= a'a''\lambda' + b'b''\mu' + c'c''\nu' + (b'c'' + b''c')\,\phi' + (c'a'' + c''a')\,\chi' \\
&\qquad + (a'b'' + a''b')\,\psi' \\
\chi &= aa''\lambda' + bb''\mu' + cc''\nu' + (b''c + bc'')\,\phi' + (c''a + ca'')\,\chi' \\
&\qquad + (a''b + ab'')\,\psi' \\
\psi &= aa'\lambda' + bb'\mu' + cc'\nu' + (bc' + b'c)\,\phi' + (ca' + c'a)\,\chi' \\
&\qquad + (ab' + a'b)\,\psi'
\end{aligned}\right\}\ (3)$$

These equations are the same as the equations for transforming x^2, y^2, z^2, yz, xz, xy.

" Introducing into the equations derived from the function V (which contains thirty-six coefficients as above specified), the conditions that the vibrations shall be normal and transversal, I obtain the following relations among the constants:

$$\left.\begin{array}{l}
(a_1b_1) = 0,\ (a_1c_1) = 0,\ (b_2c_2) = 0, \\
(a_2b_2) = 0,\ (a_3c_3) = 0,\ (b_3c_3) = 0\,; \\
(b_1c_1) + (2a_1c_2) = (b_1c_1) + (2a_1b_3) = 0, \\
(c_2a_2) + (2b_2a_3) = (c_2a_2) + (2b_2c_1) = 0, \\
(a_3b_3) + (2c_3b_1) = (a_3b_3) + (2c_3a_2) = 0\,; \\
(a_1a_2) = (b_1b_2) = (c_1c_2) - (a_3b_3), \\
(b_2b_3) = (c_2c_3) = (a_2a_3) - (b_1c_1), \\
(c_3c_1) = (a_3a_1) = (b_3b_1) - (a_2c_2)\,; \\
(a_1^2) = (b_1^2) + (2a_1b_2) = (c_1^2) + (2a_1c_3), \\
(b_2^2) = (c_2^2) + (2b_2c_3) = (a_2^2) + (2b_2a_1), \\
(c_3^2) = (a_3^2) + (2c_3a_1) = (b_3^2) + (2c_3b_2).
\end{array}\right\} \quad (4)$$

The notation will be understood by reference to my former memoir.

" These equations, twenty-four in number, reduce the function V to the following (in which X, Y, Z denote $\beta_3 - \gamma_2$, $\gamma_1 - \alpha_3$, $\alpha_2 - \beta_1$):

$$\left.\begin{array}{l}
2V = A\lambda + B\mu + C\nu + 2F\phi + 2G\chi + 2H\psi \\
\quad + P(X^2 - u_1) + Q(Y^2 - v_2) + R(Z^2 - w_3) \\
\quad + L\{2YZ - (v_3 + w_2)\} + M\{2XZ - (w_1 + u_3)\} \\
\qquad\qquad + N\{2XY - (u_2 + v_1)\}
\end{array}\right\} \quad (5)$$

" This function, containing twelve coefficients, may be reduced to a function of nine coefficients in two different ways, by the aid of the two theorems above given. In fact, let the two ellipsoids represented by the following equations be constructed:

$$\left.\begin{array}{l}
Ax^2 + By^2 + Cz^2 + 2Fyz + Gxz + 2Hxy = 1\,; \\
Px^2 + Qy^2 + Rz^2 + 2Lyz + 2Mxz + 2Nxy = 1\,:
\end{array}\right\} \quad (6)$$

it may be shown that the function V is so related to the two sets of axes of these ellipsoids, that by assuming either set of axes for axes of coordinates, we may destroy three coefficients of the function.

" Assuming as co-ordinate axes, the axes of the second of ellipsoids (6), the equation of the surface of *wave-slowness* is found to be the following :

$$(E-1)\left\{\begin{array}{c}[(x^2+y^2+z^2)\,(QRx^2+PRy^2+PQz^2) \\ +(E-1)\{(Q+R)x^2+(P+R)y^2+(P+Q)z^2\} \\ +(E-1)^2]=0;\end{array}\right\} \quad (7)$$

where

$$E=Ax^2+By^2+Cz^2+2Fyz+2Gxz+2Hxy.$$

" The equation is thus seen to be composed of two factors; the first, of the fourth degree, representing a surface with two sheets, which belong to the two transverse vibrations; the second, of the second degree, representing an ellipsoid which belongs to the normal vibration. The surface of the fourth degree may be shown to have sixteen multiple points, and consequently, its reciprocal polar, or wave surface, will be reduced from the thirty-sixth to the fourth degree.

" In the particular case in which the normal vibration vanishes, we shall have $E=0$, and the surface of transverse vibrations will become Fresnel's wave surface, as is evident on inspection of equation (7). The function corresponding to this reduction will be

$$2V=P(X^2-u_1)+Q(Y^2-v_2)+R(Z^2-w_3). \quad (8)$$

" In the last section of the memoir published in vol. xxii. Part I. of the Transactions of the Royal Irish Academy, I have directed attention to the fact, that the deduction of the laws of wave propagation is no proof of the truth of any mechanical theory of light, as this deduction may be made from several theories. There are, in fact, no less than *five* distinct theories already before the scientific public, which fulfil this essential condition, and I now publish a *sixth* mechanical theory, not because I think it superior to its predecessors, but in order, if possible, to direct attention to the unscientific state in which the question rests. It may be useful, with this view, to mention the various theories, which I shall do in chronological order:— First, Fresnel's theory; second, M. Cauchy's theory, deduced from the mathematical equations of motion of a system of attracting and repelling molecules; third and fourth, two theories of Mr. George Green, published in 1839; fifth, the late Professor Mac Cullagh's theory, published in the same year. To these may be added the theory now published. The existence of *five* rival theories is a formidable objection to each of the six, and until this objection is removed, none can claim to be the theory of Light.

"The *experimenta crucis* must be sought for in the laws of reflexion and refraction, as I have shown in my former paper. I am at present engaged in the investigation of the laws of reflexion, with the view of testing by experiment, if possible, the six theories of light. It may be interesting to observe, with respect to the direction of vibration, that in M. Cauchy's theory the vibrations are neither normal nor transversal, that in Fresnel's and Mr. Green's second theory, the vibrations are perpendicular to the plane of polarization, and that in Mr. Green's first theory, Professor Mac Cullagh's, and my own, the vibrations are parallel to the plane of polarization."

The Rev. Samuel Haughton communicated also the following note on the function peculiar to a system of attracting and repelling molecules.

"In my memoir on the equilibrium and motion of solid and fluid bodies, I have deduced the function from the supposition that the natural state of the body is one of free equilibrium.

The function deduced from this supposition contains *fifteen* coefficients only. It may be thus written:

$$\left.\begin{aligned} 2\Phi = {} & A\alpha_1^2 + B\beta_2^2 + C\gamma_3^2 + Lu^2 + Mv^2 + Nw^2 \\ & + 2(L\beta_2\gamma_3 + M\alpha_1\gamma_3 + N\alpha_1\beta_2) + 2(U_1vw + V_2uw + W_3uv) \\ & + 2u(U_1\alpha_1 + V_1\beta_2 + W_1\gamma_3) + 2v(U_2\alpha_1 + V_2\beta_2 + W_2\gamma_3) \\ & \qquad + 2w(U_3\alpha_1 + V_3\beta_2 + W_3\gamma_3); \end{aligned}\right\} (1)$$

where

$$\alpha_1 = \frac{d\xi}{dx},\ \beta_2 = \frac{d\eta}{dy},\ \gamma_3 = \frac{d\zeta}{dz},$$

$$u = \frac{d\eta}{dz} + \frac{d\zeta}{dy},\ v = \frac{d\zeta}{dx} + \frac{d\xi}{dz},\ w = \frac{d\xi}{dy} + \frac{d\eta}{dx}.$$

In the case of a homogeneous solid, this function will give Navier's equations containing only one constant.

"On examining the equations of a system of attracting and repelling molecules, obtained by a different process by M. Cauchy, I found them to contain *twenty-one* coefficients, and concluded from a hasty examination, that they could be derived from the function (1), by introducing six different constants or coefficients of $\beta_2\gamma_3$, $\alpha_1\gamma_3$, $\alpha_1\beta_2$, vw, uw, uv; which would make function (1) identical with Mr. Green's function for light. I supposed, therefore, that Mr. Green's equations were the same as M. Cauchy's, and consequently, in my classification of elastic media have called Mr. Green's function, the function of a system of attracting and repelling molecules. A more attentive consideration of M. Cauchy's equations has convinced me that this is an error, and that Mr. Green's equations do not represent the equations of a system of attracting and repelling molecules.

"It has now become necessary for me to show how M. Cauchy's equations may be derived from the principles laid down in my first memoir. This is easily done as follows:

" Referring to the memoir,* we find, adopting the notation so often described,

$$\rho + \rho' = \sqrt{\left\{ \begin{array}{l} (a + a\alpha_1 + b\alpha_2 + c\alpha_3)^2 + (b + a\beta_1 + b\beta_2 + c\beta_3)^2 \\ \qquad + (c + a\gamma_1 + b\gamma_2 + c\gamma_3)^2. \end{array} \right\}}$$

Assuming now

$$\lambda = \alpha_1^2 + \beta_1^2 + \gamma_1^2,\ \ \mu = \alpha_2^2 + \beta_2^2 + \gamma_2^2,\ \ \nu = \alpha_3^2 + \beta_3^2 + \gamma_3^2,$$
$$\phi = \alpha_2\alpha_3 + \beta_2\beta_3 + \gamma_2\gamma_3,\ \chi = \alpha_3\alpha_1 + \beta_3\beta_1 + \gamma_3\gamma_1,\ \psi = \alpha_1\alpha_2 + \beta_1\beta_2 + \gamma_1\gamma_2,$$

and developing the square root, we obtain:

$$\rho + \rho' =$$
$$\rho \left\{ \begin{array}{l} 1 + (\alpha_1 \cos^2\alpha + \beta_2 \cos^2\beta + \gamma_3 \cos^2\gamma + u \cos\beta \cos\gamma + v \cos\gamma \cos\alpha + w \cos\alpha \cos\beta) \\ + \tfrac{1}{2}(\lambda \cos^2\alpha + \mu \cos^2\beta + \nu \cos^2\gamma + 2\phi \cos\beta \cos\gamma + 2\chi \cos\gamma \cos\alpha + 2\psi \cos\alpha \cos\beta) \\ + (\alpha_1 \cos^2\alpha + \beta_2 \cos^2\beta + \gamma_3 \cos^2\gamma + u \cos\beta \cos\gamma + v \cos\gamma \cos\alpha + w \cos\alpha \cos\beta)^2 \end{array} \right\} (2)$$

neglecting terms of a higher order than the second.

" The function arising from this expansion will be (*vid.* Transactions of the Academy, vol. xxi. p. 153):

$$\left. \begin{array}{l} 2V = 2(G\alpha_1 + H\beta_2 + I\gamma_3) + Du + Ev + Fw \\ \quad + (G\lambda + H\mu + I\nu + D\phi + E\chi + F\psi) \\ \quad + 2\Phi \end{array} \right\} (3)$$

where Φ denotes function (1),

$$2G = \iiint F_0 \rho \cos^2\alpha\, d\omega \qquad 2H = \iiint F_0 \rho \cos^2\beta\, d\omega$$
$$2I = \iiint F_0 \rho \cos^2\gamma\, d\omega$$
$$D = \iiint F_0 \rho \cos\beta \cos\gamma\, d\omega \qquad E = \iiint F_0 \rho \cos\gamma \cos\alpha\, d\omega$$
$$F = \iiint F_0 \rho \cos\alpha \cos\beta\, d\omega,$$

$d\omega$ being the element of the volume.

" This function (3) contains twenty-one coefficients, and is quite distinct from the function which may be derived from Φ, by introducing arbitrary coefficients. If the terms G, H, I, D, E, F, be retained, the natural state of the body will not be one of free equilibrium, and the equations of a homogeneous body derived from (3) will contain two arbitrary constants, which appears to be more in accordance with the recent experiments of MM. Wertheim, Strehlke, and Kirchhoff, than the original result of M. Navier, which makes the equations of a homogeneous solid depend upon a single constant. If in function (3) G, H, &c., be constants, the linear part of the function will produce no terms in the equations of motion, which will become identical with the equations given by M. Cauchy for a system of attracting and repelling molecules, when we do not suppose the natural condition to be one of free equilibrium."[*]

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* Transactions of the Royal Irish Academy, vol. xxi. p. 155.

Mr. Donovan read a notice of the analysis of certain gold-coloured bronze antiquities found at Dowris, near Parsonstown, in the King's County.

"At a late meeting of the Academy a communication was made by Thomas L. Cooke, Esq., of Parsonstown, relative to certain ancient bronze articles found at Dowris in the King's County. Some specimens having been, by that gentleman, placed in my hands for analysis, I deem it proper to lay before the Academy the results of my investigation. The articles given to me were part of a celt and a portion of a horn.

"The golden hue of these ancient bronzes suggested to some persons the idea that they contained an admixture of zinc, an ingredient not hitherto, I believe, found to enter into their composition. Such bronzes in the British Museum as have been analysed consist of copper and tin only; and the Greek and Roman bronze coins are known to have been composed of the same metals. Bishop Watson, it is true, supposed that zinc constituted a part of a celt examined by him, his proof being that the metal, when melted, emitted a thick, white smoke, accompanied by a blue flame, which are esteemed, he says, certain marks of zinc. This may possibly have been the case in Bishop Watson's particular specimen, but the celts examined by other chemists proved destitute of zinc, and its introduction into the ancient bronzes must have been a very rare practice. Zinc would no doubt enhance the colour, and increase the malleability of the compound, but it would lessen its hardness, one of the chief qualities for which the metal was valued. Add to this, the test assigned of the presence of zinc is equivocal. Dr. Pearson observed a fume, to a small amount, when portions of an ancient bronze, which he proved not to contain zinc, were strongly heated; and he quotes the statements of certain assayers, who observed fumes to arise from charges of lead with silver, or lead with gold and silver, when much air is admitted. He also says that 'if much air be admitted to the alloy of copper with tin in fusion, a white smoke will sometimes be seen.'

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[*] Exercices de Mathematiques, vol. iv. p. 131.

"The specific gravity of the celt was 8·767, an indication of the presence of tin, and of the absence of zinc; but to determine the question the following process was adopted:

"A portion of the metal was dissolved by heat in nitric acid; a white powder separated, which, being edulcorated, dried, and mixed with borax and incinerated pitch, was exposed to the heat of a Russian furnace. The black mass obtained from the crucible, when viewed with a strong magnifier, disclosed thousands of metallic particles disseminated through it. By pulverizing and washing this matter, I obtained a portion of the metal: its solution in muriatic acid, mixed with a small quantity of nitric acid, afforded those appearances with solution of gold which indicate tin. The nitric solution of the celt, from which tin had been thus separated, was subjected to the action of a bright plate of lead immersed in it; the whole of the copper was thus precipitated, as was proved by the test of ammonia. The filtered liquor, now deprived of copper and tin, was mixed with solution of sulphate of soda, and boiled down to a small bulk. The sulphate of lead being filtered off, solution of potash was added, but no oxide of zinc appeared.

"Thus it was proved that the celt did not contain zinc; other trials, however, showed that it contained a little lead. In order to determine the proportions of the constituent metals, the following method was adopted: I believe it is one which differs in some respects from that hitherto practised, but previous trials convinced me that in such cases it is necessary.

"100 grains of celt metal were introduced into a tubulated retort, to which were attached a receiver, and a series of three very small Woulfe's bottles, each of which contained a little liquid ammonia; the receiver was empty. An ounce and a-half measure of pure nitric acid being poured through the tubulature of the retort, and a spirit lamp applied, a violent effervescence ensued; everything dissolved except the tin, which became peroxidated. Some acid and much nitrous gas came over, the latter of which passed through the ammonia. When the celt metal had all disappeared, the contents of the Woulfe's bottles were mixed with those of the receiver; the resulting liquor was of a light blue colour, for the nitrous gas had carried over with it some copper; it was reserved for a future process.

"The solution of nitrate of copper was diluted with distilled water, and introduced into a precipitating glass, in order that the peroxide of tin should subside. When this happened, the perfectly transparent solution of copper was decanted, and the peroxide of tin was digested with a little nitric acid, in order to dissolve away minute particles of copper, which sometimes escape solution by being entangled in the peroxide of tin. The peroxide was then well edulcorated with frequent affusions of distilled water. The collected washings were evaporated to one-eighth, and a minute quantity of peroxide of tin was thus recovered, which was added to the rest. By proper management the peroxide was drained to the last drop, dried on the capsule, collected with great care on glazed hot paper, and thence transferred to a bulbed tube of Bohemian glass, without the smallest loss. The bulbed tube had been previously heated, and counterpoised in the scale-pan of the balance. The bulb was then gradually heated until the peroxide was red-hot; the weight of the peroxide of tin was 16·678 grains, equivalent, according to the estimate of Berzelius, to 13·112 grains of metallic tin. This mode of determining the quantity of peroxide of tin I found much better than filtering and burning the filter.

"In order to discover the quantity of lead, pure sulphate of soda, in quantity known to be more than sufficient, was added to the solution of nitrate of copper. No precipitate ensued. The whole was introduced into a retort, a receiver was attached, and the acidulous water was distilled off. The process required the greatest vigilance, for the least increase of heat towards the end caused the liquid to sputter and shoot out particles in all directions, a circumstance which had imposed on me the necessity of abandoning a former analysis of this celt. At length the nitrate of copper showed a tendency to solidify, the heat was then raised until nitrous gas began to appear. The heat being withdrawn, some distilled water was added, which dissolved the nitrate of copper, but left a small quantity of sulphate of lead. This, being washed with frequent small portions of distilled water, was separated in the same manner as the peroxide of tin had been, and heated to an obscure red. Before it had cooled entirely it was ascertained to weigh 1·75 grain, which, according to the estimate of Berzelius, indicated 1·142 grain of metallic lead.

"The next step was to ascertain the quantity of copper. The washings of the sulphate of lead were added to the solution of nitrate of copper; the whole was distilled in a retort, with the same precautions as before, until the nitrate showed a tendency to solidify. At this period I connected the same series of Woulfe's bottles, still containing the ammonia, which had been used for condensing the nitrous vapour, and which also held a little copper dissolved. Through this ammonia the nitrous gas evolved from the nitrate of copper, now undergoing decomposition in the retort, was obliged to pass, previously to its emission into the atmosphere, in its passage transferring to the ammonia the chief part of the copper which it had carried over. The heat was gradually raised, and continued until the nitrate of copper was converted into a black mass.

" I have mentioned that the *chief part* of the volatilized copper was detained by the ammonia, but it was not entirely absorbed, for, at the latter end of the decomposition of the nitrate of copper, the flame of a spirit lamp, held in the fumes which escaped from the issue-tube of the Woulfe's bottles, assumed a splendid green colour. The loss in this way must be trivial.

" The bottom of the retort which contained the black mass was now cut out by means of a red-hot tobacco pipe, and the black matter detached from the glass. But so obstinately did a very small portion adhere, that it could only be removed by nitric acid; the nitrate thus formed was decomposed by heat, and the resulting black matter was added to the main product.

" In order to recover the copper which was contained in the Woulfe's bottles and receiver, the liquors were collected and distilled to a very small bulk. The distilled liquor was colourless, and, therefore, contained no copper. The residue, being transferred into a capsule, was decomposed by heat, and the very small quantity of black matter which resulted was added to the main product.

" The total quantity of black matter was now heated red-hot, by means of a Russian furnace, for about five minutes. Before it cooled, its weight was ascertained to be 106·767 grains, equivalent, according to the estimate of Berzelius, to 85·232 grains of metallic copper.

"In another analysis of the same celt, I confirmed the foregoing result by a different proceeding, which was as follows: 100 grains of the metal having been dissolved in nitric acid, and freed from tin and lead as before, the solution of nitrate of copper was precipitated by an excess of pure potash. By boiling the mixture, the peroxide of copper resulted, and this was boiled with repeated affusions of distilled water. The washings were evaporated to a small quantity, and thus a little more peroxide of copper was obtained. The whole product was filtered and dried. The filter was carefully burned on a saucer, the peroxide was heated red-hot for five minutes, and, after deducting the known weight of the ashes of the filter, the weight of the peroxide was ascertained to be 0·41 less than by the former method; but I rely more on the former estimate.

"Directed by some preliminary experiments on the celt metal, I dissolved 100 grains in two ounces by measure of pure muriatic acid, mixed with one-eighth of pure nitric acid, over a lamp-heat. A black powder was separated, which, when dried and thrown on a plate of platinum, maintained at a red heat over a spirit-lamp, burned with the characteristic blue flame of sulphur, in the midst of which could be discovered a few sparkles of burning charcoal. The sulphur had not been discovered in the former analysis, because the nitric acid being concentrated acidified it. The weight of this black powder was but 0·15 grain. Although I sought for traces of gold under the supposition that the celt might have been gilt, as some persons supposed, I could not obtain any distinct evidence of the presence of that metal.

"I next proceeded to the analysis of the horn, and conducted it with the same care. It is unnecessary to say anything more on the subject than to state the result of the two analyses. The celt consisted of—

Copper, ...	85·232
Tin, ...	13·112
Lead, ...	1·142
Sulphur and Carbon,	0·150
	99·636
Loss, ...	·364
	100

And the horn consisted of

Copper, ...	79·345
Tin, ...	10·873
Lead, ...	9·115
	99·333
Loss, ...	·667
	100

“ The loss in both cases may be partly accounted for by the escape of copper in the nitrous gas, as already mentioned, which it was not in my power to prevent. The ratio of lead in the celt is so small that advantage to the properties of the alloy could scarcely be derived from it, yet it is too great to suppose that the lead was a mere impurity of the copper. I believe antiquarians are not agreed with regard to the purpose to which celts were applied. Whatever it was, the composition of that one examined by me was admirably calculated for fabricating weapons. The metal admitted of a fine polish, and was then of a beautiful colour. Its toughness was so great that it was capable of sustaining the fiercest encounter without fracture; while its edge, by the mere process of hammering, became so hard and keen that it would cut not only through flesh but bone. It was a matter of great interest to me to discover the skilful proportions of the constituent metals, which, in times of remote antiquity, our ancestors employed in order to combine beauty with utility, and both of these objects they appear to have fully accomplished.

"In conclusion, I have to observe, that as the results of my analyses differ more or less from others which have been stated by chemists, I have been thus particular in detailing my methods. The difference of our results only proves the variety of proportions in which ancient manufacturers manipulated.

"The balance employed in these analyses turns very perceptibly with the thousandth part of a grain weight."

Professor Allman read a memoir on the Natural History of the genus *Alcyonella*.

This memoir he proposed dividing under three heads. The first was intended to embrace the *literary* history of the genus, and to contain an enumeration of the several authors who have in any way advanced our knowledge of it, with a short analysis of the various memoirs in which it is treated. The second head was to be devoted to its *zoology*, properly so called, and to contain a description of the external characters, with the diagnosis of species and synonymy. In the third it was proposed to give a detailed account of its *anatomy* and *embryology*.

It was in the month of April, 1741, that Trembley, in the course of his celebrated researches in the history of the hydra, discovered in the fresh waters near La Haye, an animal form then quite new to science. It consisted of a lobed jelly-like mass, from which protruded numerous polypoid bodies, characterized by the possession of an elegant crown of tentacula, borne upon the margin of a crescent-shaped disk. This beautiful tentacular plume is one of the most striking features in the animal, and at once suggested the name of *Polype à panache*, bestowed on it by its discoverer.

The same zeal and fidelity of observation which had marked all the previous labours of Trembley were now brought to bear upon the investigation of this new animal; and by thus making us acquainted with a very remarkable type of structure, a type which was afterwards destined to mark out a distinct and extensive order in the animal kingdom, rendered the discovery of the Polype á panache one of the most important epochs in the progress of zoological research.

The Polype á panache is closely allied to the subject of the present paper, and indeed has been frequently confounded with it; it is, however, really distinct; and the first record we have of the discovery of a true Alcyonella is to be found in a memoir presented by the celebrated Pallas to the Royal Academy of Sciences of St. Petersburgh, in the year 1768. In this memoir the author described a peculiar production which he had found in the river Kliasma, in the centre of Russia, and which he named *Tubularia fungosa.* There can be no doubt of the *Tubularia fungosa* of Pallas being identical with the animal afterwards called *Alcyonella stagnorum* by Lamarck, the best known species of the genus to whose history the present paper is devoted.

We next find Schmiedel, in his Icones Plantarum, mistaking the Alcyonella for a fresh-water sponge, and describing it under the name of *Spongia lacustris.* In 1789, Bruguiere obtained specimens from the fountain of Bagnolet, near Paris, and, evidently unacquainted with the previous labours of Pallas, described and figured them under the name of *Alcyonium fluviatile* in the Encyclopedie Methodique. His figure, however, is singularly incorrect, and in referring the animal to the genus Alcyonium he errs nearly as much as Pallas did when he described it as a Tubularia.

It is in the Histoire des Animaux sans Vertebres of Lamarck, published in 1816, that we find for the first time a distinct genus, established under the name of Alcyonella for the animal described by Pallas and Bruguiere.

In a singular and in many respects valuable memoir, published by Raspail, in the year 1828, under the title of "Histoire naturelle de l'Alcyonelle fluviatile," and accompanied by good figures, we find the strange doctrine that all the forms of fresh-water zoophytes are only particular phases of development of Alcyonella, a doctrine for which it seems only necessary to compare these different forms with one another to convince ourselves of its utter groundlessness.

In the same year with the appearance of Raspail's memoir, Meyen published in the Isis a paper entitled "Naturgeschichte der Polypen." In this paper the Alcyonella is described and figured, but the description and figures are in several cases erroneous, and the chief value of the paper is to be found in the announcement that the animal gives birth to *free ciliated embryos*,—a fact of great interest in connexion with similar discoveries which had been made among the marine representatives of the order.

After this we find the names of Ehrenberg, Gervais, Dumortier, and Vanbeneden, on the Continent, and in these islands, Teale, Johnston and Dalyell, all connected with the history of the genus. Vanbeneden, especially, has given us some most important memoirs, and has added a new species to the genus, which up to his time consisted of but a single specific form. This new species Professor Allman has within the last few months discovered upon a piece of timber, along with specimens of the old species, *A. Fungosa*, from the neighbourhood of Reading, communicated by Mr. Bowerbank.

In the second section of the memoir containing the *descriptive zoology* of the genus, the following generic and specific characters were given.

Genus ALCYONELLA. *Lamarck.*

Char. Lophophore crescentic. *Synoecium* composed of tubes adhering to one another by their sides.

Number of species, 2.

1. *A. fungosa*, Pallas. *Char. Synoecium* fungoid, formed of numerous branched vertical tubes with entire orifices. *Tentacula* about sixty. *Hab.* Attached to various fixed objects in stagnant and slowly running waters.

2. *A. flabellum*, Vanbeneden. *Char. Synoecium* formed

of branched prostrate tubes, with a transparent slit-like line which runs along the length of their free surface, and gives an emarginate appearance to the orifices. *Polypide*, with about fifty tentacula. *Hab.* Attached to various fixed objects in stagnant and slowly running waters.

Alcyonella flabellum was now for the first time recorded as a member of the British fauna. It was originally discovered by Professor Vanbeneden, in the neighbourhood of Brussels, and was now found by Dr. Allman, attached to a piece of timber taken out of a pond at Reading, and communicated by Mr. Bowerbank along with specimens of *A. fungosa.*

The third section was devoted to the consideration of the anatomical details and natural affinities of the genus.

The old notion, which by mistaking the zoological rank of the bryozoa, erroneously referred them to the class of polypes, caused the same terms to be applied to them which were also used to designate the various parts of the true polypes. The recognition, however, of a type of structure totally distinct from that of the true polypes necessitates a change in the terminology employed in their description. On these grounds Dr. Allman ventured to substitute some new terms for those previously used, while an additional number of such terms is demanded by our increased knowledge of their structure. For the term polype originally applied to the digestive canal with the tentacular crown of a bryozoon, and now no longer admissible, that of *polypide* was substituted; to the external common horny calcareous investment, which was originally together with the solid basis of the genuine polypes known under the names of polypary and polypidome, but which is really the homologue of the shell in the higher mollusca, the name of *Synœcium* was given. The internal membranous sac was called *Pallium* or *Mantle*,—a name suggested by its real import, for it is manifestly homologous with the organ of the same name in the higher mollusca. To the sort of stage which surrounds the mouth and bears the tentacula, the name of *Lophophore* was applied.

The author gave the following account of the *muscular system:*

The muscles may be divided into eight sets.

1. *The Retractor Muscles of the Alimentary Canal.*—These, which are the largest and most powerful muscles of the animal, consist of two fasciculi which arise from the lower part of the sac, and thence pass upwards, one along each side of the alimentary tract, to be inserted into the upper part and sides of the pharynx. Their *use* is very obvious; acting towards the bottom of the fixed sac they retract the whole alimentary canal, with the tentacular crown, so as to place them in a state of security in the interior of the sac.

2. *The Rotatory Muscles of the Crown.*—These also consist of two fasciculi which arise, along with the set just described, from the lower portion of the sac, and passing up in company with the retractors, separate from the latter at some distance below the crown, and thence pass outwards to be inserted each into the base of the arm of the lophophore of its own side. *Use,* to rotate the tentacular crown, and depress the lobes.

3. *The Tentacular Muscles.*—The muscular apparatus of the tentacula consist of a set of delicate bands, which arise from a peculiar structure which runs all round along the under surface of the lophophore. These bands pass upwards, and arriving at the interval between the roots of the tentacula, each divides into two others which run along the opposed sides of the tentacula. *Use,* to bend the tentacula to either side.

4. *The Elevator Muscle of the Valve.*—This is a small, but very evident fasciculus, which, arising from that portion of the lophophore which lies immediately behind the oral valve, passes forwards to be inserted into the posterior surface of the latter. Its *use* is to elevate the valve, and draw it backwards from the mouth.

5. *Parietal Muscles.*—In the walls of the pallial sac, towards its anterior extremity, may be seen, under a high magnifying power and with a carefully adjusted illumination, numerous delicate fibres which run transversely round the sac. They are, doubtlessly, muscular, and by their *action* constrict the sac in a transverse direction, and thus aid in the protrusion of the viscera. I have not succeeded in determining how far back they extend, as the structure of the sac soon becomes concealed under cover of the opaque horny cell.

6. *Superior Parieto-vaginal Muscles.*—These consist of numerous short bands which arise all round from the inner surface of the mantle, commencing close to the line of invagination, and extending for some distance downwards. They thence pass transversely inwards, and are inserted into the opposed surface of the invaginated mantle and sheath. *Use*, to dilate the sheath, and assist in keeping the upper portion of it permanently inverted.

7. *Inferior Parieto-vaginal Muscles.*—These are a set of about fourteen bands, longer and stronger than the last, below which they arise from the inner surface of the pallial sac, in a plane perpendicular to its axis, and thence passing upwards and inwards are inserted into the sheath in a plane parallel to that of their origin just below the termination of the superior parieto-vaginal muscles. *Use*, to steady the sheath, and regulate its position during the protrusion of the viscera, and to form a fixed plane on which it may roll outwards with the viscera in the act of protrusion.

8. *Vaginal Sphincter.*—The vaginal sphincter is a circular band surrounding the termination of the invaginated mantle where it passes into the tentacular sheath. Its use is to close the sheath after the recession of the viscera, and thus protect the latter from all annoyance from without.

Besides the eight set of muscles now mentioned, fibres may be detected in the walls of the stomach; but these may more properly be described in connexion with the histological structure of the digestive system.

The *nervous system* was described as follows:

"Attached to the external surface of the œsophagus, on its rectal aspect, may be seen just below the mouth, an oval body of a yellowish colour, with a cavity or ventricle in its interior. That this is a nervous ganglion there can be no doubt, and I have succeeded in distinctly tracing nervous filaments in connexion with it. From each side may be seen passing off a rather thick cord which takes a course backwards, and immediately enters the tubular arms of the lophophore. It now runs along the roof of the tube, giving off at regular intervals a filament to each tentacle upon the outer margin of the arm. When it arrives at the extremity of the arm it turns on itself, and in its retrograde course gives off similar filaments to the tentacles placed upon the inner margin. It finally terminates by uniting with its fellow at the bottom of the sinus of the crescent. Just before entering the arms, filaments are sent forwards to the tentacles, placed upon the anterior margin of the lophophore. From the upper edge of the ganglion some filaments would seem to pass off to the mouth and its valvular appendage, and from each side a filament passes forwards to embrace the œsophagus; but I could not succeed in tracing a perfect collar round this tube. Round the margin of the lophophore at each point, corresponding to an interval between two tentacula, may be observed a minute brilliant spot, an appearance which, perhaps, we may truly interpret as a special organ of sense. This opinion, however, is one which I throw out with much diffidence, and one which will require further corroboration before it can be viewed as established."

The author gave the following description of the *free locomotive embryos* of Alcyonella:

"While engaged in the examination of a specimen of *Alcyonella fungosa*, in the month of October last, I liberated from the mass an active locomotive animalcule, possessing certain points of resemblance with the adult Bryozoon, of which it was evidently one of the early phases of development. It consisted of a common sac enclosing two imperfectly developed polypides. The sac is invaginated at its anterior end. All that portion of it which lies behind the line of invagination is thick and very irritable, and densely covered with long cilia. From the invaginated portion of the sac the double set of viscera were suspended as in the adult animal, and were capable of partial exsertion, the invaginated portion then rolling outwards upon itself to within a certain distance of the line of invagination, where its further evolution was checked by bands in every way similar to the inferior parieto-vaginal muscles of the adult. The two sets of viscera were unequally developed, but in both the general structure of the adult could be seen. The pharynx, stomach, and intestine could be traced, and the tentacular crown was also very evident. The tentacula, however, were short and thick, and they seemed less numerous and distinct than in the fully developed animal. Both the superior and inferior sets of parieto-vaginal muscles were already very evident, but I could not detect any others, though from the existence of a power of exsertion and retraction it is pretty certain that at least the long retractor muscles must have been present. The internal surface of the common sac and the external surface of the stomach were covered with a loose granular layer. From the description now given of this little larva it will be seen that the present account differs considerably from that given by Meyen in the Isis, 1848. Meyen was the first to describe the locomotive larvæ of Alcyonella, but he mistakes the ciliated sac for the external envelope of an egg containing two embryos. This egg, he tells us, becomes ruptured at the anterior extremity, and allows the embryos gradually to escape. The bodies, however, described by Meyen and myself are physiologically of a nature totally different from eggs; they are in reality embryos containing a double system of digestive and respiratory organs, and destined to undergo an ulterior development in all their parts."

The existence of egg-capsules with a circular aperture in the centre of one of the faces was also recorded. These bodies were found in *Alcyonella fungosa*, and in *Lophopus crystallina*.

The Secretary exhibited several donations of antiquities.

February 11th, 1850.

The REV. HUMPHREY LLOYD, D. D., President, in the Chair.

Sir Robert Gore Booth, Bart., was elected a Member of the Academy.

The Secretary read the following Report of the Council:

"The attention of your Council has been recently directed to the important object of organizing, under the auspices of the Academy, a system of meteorological observations in Ireland, similar to those now in operation in different parts of Germany; and it becomes their duty now to communicate to the Academy the views by which they have been guided respecting it, and the steps which they have taken in consequence.

"In that department of meteorology which relates to the geographical distribution of temperature, conclusions of great scientific interest, and of much practical value, have been recently drawn from the study of the varying position of the isothermal lines *from month to month.* Every country in which science is cultivated will be hereafter expected to contribute its own share to the full elucidation of this subject.

"In what may be called the *dynamics* of meteorology, on the other hand, there are numerous,—and among them, perhaps, some of the most interesting problems of the science,—which can be solved only by means of observations made over a large area, and upon a common plan. Of these it is sufficient to refer to the various questions relating to the course and direction of the aerial currents, and the non-periodic variations of temperature and pressure connected with them.

"For the data required in the solution of these, and such problems,—so far as they relate to Ireland,—the Council believe that the meteorologists of Europe have a right to look to the Royal Irish Academy.

"Your Council are moreover of opinion, that there are special grounds for an undertaking, such as that referred to, in Ireland. While, on the one hand, the position of the island in the north-western extremity of Europe, its insular climate, the peculiar relation of its surface to the curves which define the limits of the greater precipitations of vapour, and the probable influence of the gulf-stream, concur to give importance and interest to its climatology; on the other, the means for the investigation probably exist to as great an extent in it as in any other country of Europe, and need only to be organized for the purpose.

"In reference to this latter point it is important to observe, that the system of observation required (although necessarily demanding punctuality and attention) is not a complex one. It is not necessary that the regular observations should, in any case, be more frequent than *three* daily; and it is probable that, with the knowledge we already possess respecting the diurnal variations of the meteorological elements, a yet more limited plan of observation will suffice at most of the stations.

"Additional information of great scientific value may be obtained, without much additional labour, by combining tidal observations, at selected stations round the coast, with the meteorological observations above referred to. The phenomena of the tides on the coasts of Ireland present many points of striking interest, which have been brought to light by Mr. Airy, in his able discussion of the tidal observations made in 1842, in connexion with the Ordnance Survey of Ireland. Of these observations Mr. Airy observes, that 'extent of time alone appears wanting to render them the most important series of tide observations that has ever been made.' The duty of endeavouring to supply this want naturally devolves upon the Academy.

" In furtherance of the views expressed in this Report, your Council have agreed to the following resolutions :

" 1. That an application be made to the Board of Trinity College, to the Earl of Rosse, to the Rev. Dr. Robinson, to Mr. Cooper, to the Presidents of the Queen's Colleges at Cork, Belfast, and Galway, and to the Chief Commissioner of the Board of Works, requesting their co-operation.

" 2. That an application be made to the Lords of the Treasury, to request that they will direct the meteorological and tidal observations, referred to in the Report of the Committee of Science of the 7th January, to be made by the officers of the coast guard, at not less than fifteen stations round the coast of Ireland, for at least one year, the Academy undertaking to furnish the instruments and instructions for their use.

" 3. That the Committee of Science be authorized to procure estimates for the cost of the instruments required, to be laid before the Council at a future meeting."

On the recommendation of the Council it was

RESOLVED,—That the sum of £150 be placed at the disposal of the Council for the purposes stated in the Report.

The Secretary read a note from R. J. Graves, Esq., M. D., announcing the invention of a method by which he proposed to prevent the waste of water by evaporation from tanks and reservoirs, in hot climates.

Mr. George Yeates presented the results of his Meteorological Observations for the year 1849.—(See Appendix, No. VI.)

Mr. M. Donovan read a biographical memoir of the late Richard Kirwan, Esq., LL. D., formerly President of the Academy.

FEBRUARY 25TH, 1850.

The REV. HUMPHREY LLOYD, D. D., PRESIDENT, in the Chair.

The Secretary read an Eulogium on the late Richard Kirwan, Esq., LL.D., by Dr. Pickells, of Cork.

Mr. Kirwan had been educated for the Bar, and practised for some time this honourable profession, but having unexpectedly succeeded to an ample patrimonial income by the death of his elder brother, who was killed in a rencontre while in the act of entering the Irish House of Commons, a new direction was given to his views and energies, and thenceforward he devoted himself in dignified retirement to the pursuits of science. The sciences to which Mr. Kirwan more particularly applied himself were chemistry, mineralogy, including geology, and meteorology; and that his contributions to each of these departments of natural knowledge were of the highest importance cannot be doubted, although his name is not connected with any of those transcendent or dazzling discoveries which secure immortality for their author, and mark, as it were, an era in the intellectual progress of the human race. In chemistry his researches were numerous and valuable in a high degree. By him, for the first time, the phenomena usually referred to double elective affinity were studied with accuracy and success, and the attention of chemists fixed upon the antagonist forces, which he distinguished by the terms *Quiescent* and *Divellent*. He even attempted to assign measures of the degree of the affinity between acids and bases, an effort which, had it been successful, would have raised chemistry to the rank of the more exact physical sciences, and have brought its results within the domain of mathematical calculation.

In an early communication to this Academy he explained very accurate methods of determining the strength of the mineral acids so much employed in medicine and the arts. In his essays on the alkaline substances used in bleaching, he pointed out the resinous nature of the colouring matter of linen yarn, and established, as he conceived, the fact,—important in a national point of view,—that the linen manufacture of Ireland is altogether independent of foreign salts or ashes for the purposes of bleaching. Next followed his experiments on the proportions of carbon in bitumen and mineral coal, and his essays on the analysis of soils, and the nature and manner of action of the manures best suited to each locality. From this enumeration of his chemical labours, they would appear to have been chiefly directed to objects of immediate practical utility. This, however, was not always the case, for he turned special attention to one of the most difficult departments of the doctrine of caloric, and communicated a table of specific heats, which was published by Magellan, and had some celebrity.

Chemists of the present time, who know in what a chaotic state their science was in the days of Kirwan, will not hesitate to award to him the merit of having been an acute reasoner and a laborious experimenter; and will not, looking to the period in which he lived, consider it any serious reproach to him, that he was a strenuous supporter to the last of the phlogistic theory, which, however, it must be confessed he continued to maintain long after any satisfactory evidence could be adduced in support of it.

In the department of mineralogy the exertions of Mr. Kirwan may be said to have had a national importance. To him is undoubtedly due the merit of having introduced the study into this country. The celebrated Leskean collection, in the possession of the Dublin Society, was acquired through Mr. Kirwan, who passed over to Germany for the purpose of purchasing it; and, as Inspector-General of Irish mines, he addressed an able memorial to the Irish Government, pointing out the economic importance of mineralogical science, and bespeaking for it support and encouragement.

The advancement of the study of meteorology was with Mr. Kirwan a favourite object, and he devoted to it much attention. Adopting the formula of Mayer, he constructed a table showing the temperature of every latitude between the Equator and the Pole, and endeavoured to show that it was in accordance with observations.

In his essay on "the variations of the atmosphere," he studied the subject of temperature as affected by elevation, and other correlative topics of high interest; and was one of the first to suggest, as a means of improving meteorological science, the establishment of corresponding societies in different parts of the world, pointing out the important results to be anticipated from a combined system of observation. In connexion with his meteorological labours, it will not be out of place to mention that he published "Thoughts on Magnetism," his views in relation to the aurora borealis, a design for an anemometer, which has been praised by Howard, and numerous other papers on subjects of minor importance.

Dr. Pickells, in conclusion, observes: "With every disposition to celebrate his worth, it would, after all, be presumptuous to deny that the task of rendering full justice to merit so varied and transcendent will still await and solicit the execution of a more competent hand. Meanwhile departed genius will not disdain this humble tribute at its tomb. Thirty years* have now elapsed since that tomb closed upon the remains of the illustrious Kirwan, but his memory cannot fade with the lapse of time. The gratitude of mankind will attest his services; and history, in tracing the progress of those sciences which he cultivated, and to the prosecution of which by others he gave so powerful an impulse, will perpetuate to late posterity the honours of his name."

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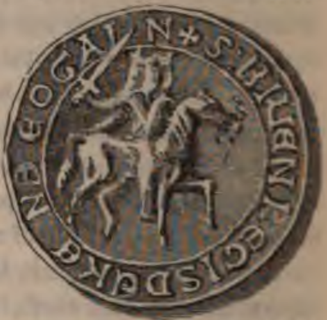
* Dr. Pickell's paper was first read before the Chemical Section of the British Association for the advancement of Science, in Cork, in the year 1843.

As an appendix to this abstract of Dr. Pickells' memoir, it will be proper to mention that Mr. Kirwan, for some papers read by him before the Royal Society, at the very commencement of his scientific career, was voted the Copley Medal; and that he was immediately afterwards elected President of this Academy; a distinction with which he continued to be honoured up to the period of his death.

Sir William Betham exhibited an impression of an ancient seal, lately found near Beverley in Yorkshire, on which is represented a mounted cavalier with a very long sword drawn in his hand, round which is the following inscription :



S. BRIEN. REGIS . DE KENEL.
EOGAIN.

Brien O'Neill was King of Kinel Owen, or Tyrone, from A. D. 1241 to 1260, when, along with many others of the Irish chieftains, he was slain in the battle of Drom Deirg, or Down. His head was cut off and sent to King Henry III. ; and probably this seal fell into the hands of the English victors, who carried it to England, and this accounts for its being found in Yorkshire.

The Annals of the Four Masters have the following account of the battle.

1260.—"The battle of Drom Deirg, at Downpatrick, was fought by Brien O'Neill and Hugh O'Conor (King of Connaught) against the English of the north of Ireland, in which many of the Irish chiefs were slain, namely, Brien O'Neill, the chief ruler of Ireland ; Donall O'Cairre, Dermod M‘Loughlin, Manus O'Cahan, Cane O'Henery, Donslevy MacCan, Conor O'Duvdirma, and his son, Hugh O'Cahan ; Murtogh O'Cahan, Aulave O'Gormley, Cu-ula O'Hanlon, with many of the Connaught chiefs."

The English army was commanded by Stephen de Longespey, third son of William de Longespey, natural son of King Henry II., by the Fair Rosamond, who became Count de Rosmar in Normandy, and Earl of Salisbury in right of his wife, Ela, daughter and sole heiress of William D'Eurieux, Count de Rosmar and Earl of Salisbury. Stephen was married to Emmeline, daughter and heiress of Walter de Riddlesford, and relict of Hugh de Lacy, first Earl of Ulster. He has been sometimes styled both Earl of Salisbury and of Ulster, even by Ware, but he really was neither. He was made Lord Justiciary of Ireland in 1258, 44 Hen. III.

This Brien is mentioned on the records in the Tower of London, where, on the Close Rolls, is a writ directed to *Brien O'Nel Regi de Kinelun*, to go with the Justiciary of Ireland, with horse and arms, to join the King's army, then on an expedition to the parts of Scotland. If he went, his seal may have been lost on this occasion.

On the great Roll of the Pipe of the Irish Exchequer are the following entries:

"Compotus Ulltoniæ anno Regni Regis Henrici secundo xlv. Nich. de Dunhened Senescallo.

"Bren O'Nel M. vacc. pro transgress. quas solvere debet ad tres terminos, sicut continetur in Rotulo xliii.

"Idem Bren Regulus de Kinelun C. lib. de auxilio Dñi Regis ad guerram suam in Vasconiam sustinendam.

"Hibernienses de Turtere CC. lib. pro eodem.

"Turtere pro eodem xx lib.

"O Nel Regulus de Kenelun MMM $\overset{\text{xx}}{\text{IIII}}$ XII.[*] Vacc. de fine facto cum Justiciario.

"Idem O Nel CCCC. Vacc. pro arreragiis redditibus."

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[*] 3092 cows—three thousand four score and twelve.

Dr. Henry Kennedy read a paper on the progress of epidemics.

The object of this paper was to show that a great general law existed, which appeared to regulate the progress of all the more wide-spread epidemics which have passed over Europe within authentic records; that this law exhibits a progressive movement, and that this movement is from east, or south-east; to west, or north-west.

The paper was illustrated by a printed chart, which offered, in one view, an outline of almost all the great epidemics of which there is any account. The writer further showed that, in the diseases of the lower animals, the same law also obtained, and that in America the same had been observed when the vegetable world was affected with blights.

Notice was likewise taken of the fact that great cold had, on different occasions, been found to move from east to west.

From these several facts the writer concluded that some general law exists, regulating the progress of epidemics; and that the existence of this law must alter materially the views commonly held on the spread of epidemic sickness by either famine or contagion.

The writer confined himself exclusively to the consideration of the general law, and said he hoped to be allowed, on some future occasion, to make some deductions from it.

The President exhibited a diagram, representing the oscillations of the barometer from December 18th, 1845, to the present date.

The Secretary read a letter from Robert James Graves, Esq., M. D., containing a development of the method by which he proposes to prevent the waste of water, by evaporation, from tanks and reservoirs, in hot climates.

"In certain regions of the earth nature has placed obstacles apparently insurmountable, to the free and comfortable enjoyment of existence; one of these has hitherto baffled all the efforts of art, and is caused by the prevalence of drought: thus, in Australia rain falls at certain periods of the year in such great abundance, that the rivers overflow their banks, and large tracts of country are entirely inundated for a considerable length of time; shortly after the close of the rainy season the water subsides, and in the course of a few weeks, so great has been the evaporation, that where deep and rapidly flowing rivers existed, nothing remains but stagnant pools, water-holes, and lake-like reaches of the rivers, occurring at intervals in their former beds. These natural reservoirs of water are of the most vital importance to the colonists and their extensive flocks. But there are many seasons, during which the air becomes so extremely hot and dry, that even those reservoirs are dried up, and man and beast are forced to quit the now inhospitable district. A similar defect of climate exists in many other countries, such as Hindostan, Scinde, and those kingdoms bordering on the banks of the Euphrates, which were the very first settled and occupied by civilized peoples. Man has in all these places struggled from the earliest periods to secure for himself a sufficient and continuous supply of water, the life-blood of living beings, whether animal or vegetable. To promote an object of such paramount importance, we find that national works of the most expensive and magnificent description have been undertaken by the rulers of those countries; thus, in Hindostan the Mogul emperors have each emulated his predecessor in the construction of tanks of immense magnitude, and at an enormous expense, to preserve the necessary supplies of water during the dry season. The Kings of Ceylon even exceeded the Mogul emperors in the size of their tanks, constructed for the same purpose; while in Mesopotamia, and the countries watered by the Tigris and Euphrates, as likewise in Persia and Affghanistan, the inhabitants resorted to the expedient of constructing reservoirs under ground, and in some instances they even went so far as to conduct rivers league after league beneath the soil, in order to obviate the evil results of evaporation: each village having a well, by means of which they were enabled to draw up the treasures of these subterraneous currents. In Constantinople the Greek emperors built extensive arched reservoirs for holding water, and from which a considerable portion of the city was supplied with this indispensable element.

" To persons living in this moist climate it may appear of very little importance to guard against the evaporation of water, and the effects arising from it; but to the philosopher, who, by experiments in his laboratory, has made himself familiar with the power of evaporation; or the traveller, who, like Mr. Strutt, has seen in Australia evaporation carrying off daily from reservoirs the water upon which his own life, and that of his companions and cattle, depended; and who has marked the appalling rapidity with which it disappears, when the air has become dry and parched from the great heat prevailing;—to such, I say, it must appear evident, that evaporation may become so intense as to render nugatory all efforts to preserve any large supply of water in open tanks or reservoirs, and thus prevent the colonization of countries in other respects most desirable. Sir T. L. Mitchell observed the thermometer at 126° in the shade, under the influence of the hot dry wind of Australia. How rapidly must evaporation proceed, when water is exposed to such a wind!

" It is my object to show, that this great source of waste can be effectually prevented, and that too by very simple means; and that the surface of reservoirs, tanks, water-holes, and ponds, in the hottest climate and warmest weather, can be, for the most part, preserved from the loss occasioned by evaporation.

" The method which I propose for resisting the evaporation of water could not have been either thought of or applied before the present time, when a succession of discoveries has rendered us masters of many vegetable substances, such as Indian-rubber, gutta-percha, &c., which, after passing through certain simple processes, may be made available for rendering linen, cotton, woollen cloths, and canvass, when even of the finest texture, impervious either to air or water. It is by the help of such prepared canvass that the contrivance I am about to describe is to be carried into execution.

"Those who are practically versed in this department of art, will readily suggest what species of impermeable water-proof canvass is best adapted in practice for accomplishment of so desirable an end. For me it is sufficient to know that such a material can be manufactured at a cheap rate, of a light but strong texture, and in sufficient quantities to cover, as with a carpet, any extent of water that may be necessary. When a piece of water is to be protected from evaporation, its water-proof carpet may be spread by the following simple means:—at suitable distances from each other on the canvass, and made of the same material, are to be inserted pouches or bags, which, when it is wished to float the canvass on the water, may be inflated with air in the usual manner; when not in use, these bags need not, of course, be otherwise than in their collapsd condition. Let us suppose a piece of canvass nine feet in breadth, and 150 in length, having three bags in rows, twelve or fifteen feet distant from each other; let us suppose such a piece of canvass placed on the water of a tank, it will then protect from evaporation a surface corresponding to its own extent. Similar pieces might be attached, by tying together their sides and ends, until the whole surface was similarly protected. All this could be done without much labour or trouble: the canvass could be carried in a boat, and dropped from its stern, in the same manner as fishermen drop their nets, the men inflating each row of pouches or bags at the time it became necessary to cast them in; ropes could be also fastened to the extremities of the piece, so as to connect it with the bank or other boundary of the s water, loops being attached to their extremities for tl pose. Such canvass could be easily spread out or ha and would effectually prevent, while over the water, a poration taking place, no matter how dry the atmospl how intense the heat of the sun. Neither would this have the inconvenience that at first it is apparently li of heating the water in the tank, &c.; for we know th cannot be easily heated from above, inasmuch as th warmed at the surface becomes specifically lighter, an being incapable of sinking, forms a superficial stratum, prevents the propagation of the heat downwards. It dent that by this method a considerable quantity of the ing, sufficient, indeed, to form a non-evaporating surfa large ponds, water-holes, &c., might be carried by a horse. When an exploring party, so provided, arriv pond, water-hole, &c., they can readily cover it, eit carrying ropes round the piece of water, or by means or two men swimming across, holding the ropes attac the edge of the canvass; thus may be preserved for m supply, which, if left exposed to the absorbing influ the atmosphere, would have vanished in the course o weeks.

"The following extract from the work of Lieu Colonel Sir T. L. Mitchell, Surveyor-General of New Wales, proves that the preservation of water will he form in Australia the most essential feature in agric and consequently every means adapted to facilitate tl ject, will be of the greatest value in that extensive fi British colonization and enterprsie:—'With equal tr may be observed, that there is no region of the earth s tible of so much improvement, solely by the labou ingenuity of man. If there be no navigable rivers, th no unwholesome savannas; if there are rocky ranges afford at least the means of forming reservoirs of wate although it is there uncertain when rain may fall, it is certain that an abundant supply does fall; and the hand of man alone is wanting to preserve the supply, and regulate its use. Where natural resources exist, but require art and industry for their development, the field is open for the combination of science and skill, the profitable investment of capital, and the useful employment of labour.'

"The preceding extract distinctly shows (what indeed is confirmed by other travellers) that civilized man will be unable to form permanent settlements in the extensive and fertile regions forming the interior of Anstralia, unless he can call to his assistance means adequate to overcome the formidable difficulty presented by want of water, during several months of the year. The method I have invented, by which we can readily and cheaply cover even a large surface of water, will, no doubt, greatly facilitate the accomplishment of what would be otherwise, in many localities, unattainable. Instead of the expense of vaulting over reservoirs, or covering tanks, we can now make the *water itself support its own roof*—a roof, it is true, thin and delicate of structure; but, nevertheless, by reason of its impermeability, not less capable of preventing evaporation than if it consisted of the most solid masonry. The floating carpet, or roof, possesses the great additional advantage of rising or falling, according as the quantity of water in the reservoir increases or diminishes, so that all access of air to its surface, and consequently all evaporation, is prevented. This covering, being opaque, will keep the water perfectly in the shade, a circumstance, which, combined with deficient ventilation, would in itself much retard evaporation, as is exemplified even here by the wetness of roads overshadowed by trees, and by the water remaining in ditches, when covered by *lemna* or duck-weed, so long after the summer heats have dried up all other ditches in their neighbourhood. In some parts of Russia, where the weather is very hot in summer, the peasants use water-tubs with floating covers of wood, and which are said to answer the purpose perfectly, both of preventing loss by evaporation and keeping the water sweet."

March 16th, 1850. (Stated Meeting.)

The REV. HUMPHREY LLOYD, D.D., President, in the Chair.

The Secretary of the Academy read the following Report from the Council:

During the past year the first part of the twenty-second volume of the Transactions of the Academy has been published. The second part of the volume is nearly completed, and a copy of it, in sheets, is now laid on the table of the Academy. The Proceedings have also appeared as usual, although we regret to say, that, owing to some temporary difficulties, the Proceedings of three or four of our late Meetings are still in arrear.

The Museum of the Academy was honoured in the month of August last by a private visit from His Royal Highness the Prince Albert, accompanied by His Excellency the Lord Lieutenant, and several other distinguished noblemen. His Royal Highness was pleased to take a very great interest in the antiquities exhibited to him; and on leaving the Museum expressed much gratification with the collection.

The Committee of Science have been engaged for the last few months in the consideration of a measure of considerable importance, of which the substance has already been laid before you. They have proposed to the Council to organize, under the auspices of the Academy, a system of meteorological observations in Ireland, similar to that which has been recently carried out in various parts of Germany. They have shewn that Ireland, from its geographical position, and other causes, affords a peculiarly favourable field for such observations; and there is every reason to hope that if the proposed arrangements can be carried into effect, a most valuable body of information, furnishing materials for the solution of some very important meteorological problems still undecided, may, in a few years, be collected in this country, at a trifling expense.

The Council had, therefore, no hesitation in recommending this proposal to your adoption, and having obtained your sanction, they have taken steps to bring the subject under the notice of those individuals and public bodies whose co-operation is necessary to the success of the undertaking.

A communication from the Rev. Dr. Robinson, as President of the British Association for the Advancement of Science, has also directed the attention of your Council to a subject of great importance, namely, the reduction of the heights in the maps published by the Ordnance Survey of Ireland, to the level of the mean tide. The subject was referred to the Committee of Science, and upon the recommendations made in their Report, your Council have agreed to the following resolutions:

"That the levels of the beach marks, erected during the progress of the levelling operations undertaken in connexion with the tidal observations round the coast of Ireland, be published in detail.

"That the levels of the new edition in the Ordnance Maps of Ireland be referred to the mean tide, in case the work be not already too far advanced, to render such an alteration inexpedient.

"That the height of the mean tide, above the Ordnance zero plane, be engrossed on each sheet of the old edition."

The Council have also taken steps for the publication of a Catalogue of your Museum, and have requested Dr. Petrie to undertake this task, under the superintendence of the Committee of Publication. They propose to print, in the first instance, such a Catalogue of the Museum as will assist the public or the student in the intelligent examination of its contents; with such descriptions only as are necessary for identifying the several articles, referring them to some judicious classification, putting on record their history, and ascertaining their probable dates. It is hoped that this may be done within the limits of an octavo volume, of about 300 or 350 pages; and it is proposed to illustrate and assist the description of the several articles by a few well e wood-cuts, representing such of them as are unique or es remarkable, or which may be considered typical of a class.

Dr. Petrie has fully entered into the views of the Cou this subject, and has kindly consented to undertake the although the limited funds at the disposal of the Academ compelled the Council to offer him a remuneration whic cannot but feel to be much below the real value of his servi

With a view to the preparation of the catalogue, the w the Museum has been newly arranged by Mr. Clibborn; an articles of value and interest, which had formerly been co in drawers, have now been brought to light, and properly di in the room.

During the past year seven Honorary and fifteen O Members have been elected by the Academy. The followi our new Honorary Members:

His Royal Highness the Prince Albert.
Alexander Von Humboldt.
Jacob Grimm.
Franz Bopp.
Carl Reickhard Lepsius.
Francois Pierre Guillaum zot.
Leopold Ranke.

The following are the names of the Ordinary Members into the Academy during the past year.

Daniel Fred. Brady, Esq., M.D.
Benjamin Lee Guinness, Esq.
Henry Kennedy, Esq., M. D.
Hon. Thomas Vesey, Esq., M.P.
William Fraser, Esq.
William H. Luscombe, Esq.
Lord William Fitzgerald.
Rev. Henry King, LL. D.
Charles George Fairfield, Esq.
Chichester Samuel For Esq., M. P.
Charles Fox, Esq.
Alexander Gordon Me Esq., M. D.
Christopher Moore, Esq.
Wellington A. Purdon, E
Sir Robert Gore Booth, M. P.

We have lost by death during the past year six Honora eight Ordinary Members.

The Honorary Members deceased are the following :—

- Maria Edgeworth.
- Count Graberg.
- Sir Graves Chamney Haughton.
- The Right Rev. Edward Stanley, Lord Bishop of Norwich.
- Dr. Jacquine d'Acosta Macedo.
- William Reid Clanny, M. D.

These are names that need no eulogy, and many of them have left a blank in the world of letters that must long remain to remind us of their loss.

Miss Edgeworth was one of the few female writers who have been admitted to the distinction of being elected Honorary Members of the Academy ; her writings are in everybody's hands, and have done more, perhaps, than those of any other author of our day, to raise the moral tone of our lighter literature, to diffuse correct views on the nature of intellectual education, and to bring forward in a popular and favourable manner the character, peculiar circumstances, and wants of the Irish people. Miss Edgeworth closed her long and useful life at Edgeworthstown, in May last, regretted by the public, and mourned by all who had the pleasure and privilege of her acquaintance.

Sir Graves C. Haughton died on the 28th of August last, at St. Cloud, near Paris, in the sixty-second year of his age. Although his life was passed in other countries, he was a native of Dublin, the son of Irish parents. His father was an eminent physician here. At an early age he was sent to India as a cadet, and distinguished himself by his knowledge of Oriental languages. On his return home he became Professor at Haileybury College, and received the honour of knighthood in 1833. He was the editor of the *Institutes of Menu*, in the original Sanscrit, and published a Bengali Grammar, a Bengali Sanscrit and English Dictionary, and several other works. His "Inquiry on the Nature of Language" was introductory to an intended larger work, which he unhappily did not live to finish.

The Right Rev. Edward Stanley, Lord Bishop of Norwich, was distinguished in the scientific world for his attachment to the study of natural history, although his only publication on the subject was an elementary one, a Familiar History of British Birds, intended for the use of young persons. He was for many years President of the Linnæan Society, and was also an active Member of the British Association. He was elected an Honorary Member of the Academy in 1836.

DR. CLANNY was a native of the county Down. He served as an assistant surgeon in the British navy, and was present in the battle of Copenhagen, under Lord Nelson. He settled for a short time at Durham, but afterwards removed to Bishopvearmonth, where he practised as a physician for forty-five years. Living in a coal district, where fatal explosions in the mines were frequent, his attention was turned to the best mode of preventing such accidents; and he produced in 1813 his well-known safety lamp, the first attempt to produce a lamp capable of burning without danger in an explosive atmosphere, an account of which was published soon after in the Philosophical Transactions. For this invention, which appears to have been prior by two years to the similar lamp of Sir Humphrey Davy, Dr. Clanny was rewarded with the gold and silver medals of the Society of Arts; and in the beginning of the year 1848, a number of gentlemen interested in coal mines, headed by the Marquis of Londonderry, presented him with a piece of plate and a purse of gold, as an acknowledgment of his valuable services.

Dr. Clanny was the author of many professional works, and papers in the Transactions of learned societies. He died 10th January, 1850.

The ordinary Members deceased during the past year are the following:

GEORGE CARR, Esq., died in May, 1849. He was elected a Member of the Academy March 16th, 1836; and although he was never on the Council, and took no part in the scientific or literary proceedings of the Academy, yet it will be in the recollection of many Members that Mr. Carr was always ready and active whenever any subscription was set on foot for the purchase of antiquities, or the preservation of our ancient literature; and that to him we are indebted for many valuable additions made in this way to the Museum.

Richard Carmichael, Esq., was elected a Member in March, 1812, and served for some time on the Council. His eminence as a surgeon, and his contributions to the literature of that profession, have made his name well known in every part of Europe; and his zeal for the advancement of science, particularly in the departments to which his life was devoted, was manifested by the munificent bequests which he has left behind him for the endowment of professional institutions, and the support of medical charities in this city. Mr. Carmichael's death took place on the 8th of June, 1849.

William Murray, Esq., died 11th June, 1849. He was elected a Member of the Academy in January, 1830.

The Hon. Frederick Ponsonby died in June last; he was elected a Member in January, 1843.

Lord Walscourt died 28th May, 1849; he was elected a Member of the Academy in November, 1844.

The Rev. John Connell, Chaplain of the Royal Hospital, Dublin, died at Bath in October last. He was a Member of the Academy since January, 1846.

Sir Richard Morrison, elected a Member in January, 1835, died in October, 1849.

The Rev. Charles Richard Elrington, D. D., Regius Professor of Divinity in the University, died at Armagh, January 18, 1850. He had been a Member of the Academy since May, 1816, and was for years an active and useful Member of Council. He was elected a Fellow of Trinity College in 1810, and resigned his Fellowship on being appointed to the Professorship of Divinity in 1829. His loss will be deeply felt in many of the public institutions and charitable societies of Dublin, of whose governing bodies he was a zealous and influential member for many years. Dr. Elrington was well known and highly respected, both in this country and in England, for his learning and theological attainments; and his edition of Ussher's works will continue to preserve his memory in connexion with one of the greatest names of our national literature. It is matter of congratulation to his friends, that Dr. Elrington was permitted to live until after he had completed his Life of Archbishop Ussher, a work of high and increasing reputation, that reflects the utmost credit on the learning, the industry, and ability of the author, and will doubtless hold a permanent place in the historical literature of Ireland.

It was resolved,—That the Report of the Council be adopted, and printed in the Proceedings.

The Ballot for the annual election having closed, the Scrutineers reported that the following gentlemen were elected Officers and Council for the ensuing year:—

President.—Rev. Humphrey Lloyd, D. D.

Treasurer.—Robert Ball, LL. D.

Secretary to the Academy.—Rev. James H. Todd, D. D.

Secretary to the Council.—Rev. Charles Graves, A. M.

Secretary of Foreign Correspondence.—Rev. Samuel Butcher, D. D.

Librarian.—Rev. William H. Drummond, D. D.

Clerk and Assistant Librarian.—Edward Clibborn.

Committee of Science.

Rev. Franc Sadleir, D. D., Provost; James Apjohn, M. D.; Robert Ball, LL. D.; Sir Robert Kane, M. D.; George J. Allman, M. D.; Sir William R. Hamilton, LL. D.; Rev. Samuel Haughton, A. M.

Committee of Polite Literature.

The Archbishop of Dublin; Rev. William H. Drummond, D. D.; Rev. Charles W. Wall, D. D.; John Anster, LL. D.; Rev. Charles Graves, A. M.; Rev. Samuel Butcher, D. D.; Rev. Nicholas J. Halpin, A. M.

Committee of Antiquities.

George Petrie, LL. D; Rev. James H. Todd, D. D.; J. Huband Smith, A. M.; Captain Larcom, R. E.; F. W. Burton, Esq.; Samuel Ferguson, Esq.; Aquilla Smith, M. D.

April 9th, 1850.

The REV. HUMPHREY LLOYD, D. D., President, in the Chair.

Signior Bassilio Angeli, W. H. Hardinge, Esq., and Robert Fowler, Esq., were elected Members of the Academy.

Mr. J. Huband Smith exhibited to the Academy an ancient manuscript, said to have belonged to the Abbey of Bonamargy, near Ballycastle, in the County of Antrim. It has been for many years in the possession of the Boyd family.

The manuscript is closely written, in a very beautiful hand of the fourteenth or fifteenth century, on eighteen leaves of vellum, or thirty-five pages (the thirty-sixth being blank), in two columns on each page. The capital letters at the beginning of each section are in gold, surrounded with flowers, whose colours are nearly as bright as at the first. Some prayers, hymns, &c., are written in red letters, and are afterwards given in English. The whole is written uniformly throughout in one hand, except the last four lines, which appear to have been subsequently added by two different persons, by the latter of whom the manuscript is styled "The History of the Blessed Scriptures," and the name "George Theaker" is subscribed.

At page 30, column 1, the following words are written in red letters: "Explicit Liber Aureus de passione et resurreccione Domini, per dominum Bonaventuram Cardinalem, cujus animo propicietur Deus." From this it may be concluded that the preceding part of the manuscript is from a tract of Bonaventure's. The remainder of the manuscript is probably from another tract of the same writer. He was born A. D. 1221, became a Franciscan monk in 1243, was created Cardinal Bishop of Alba in 1274, and died at Lyons during the sitting of the Council, July 15th, A. D. 1274, aged 53. His works were printed in Rome in 1550, in eight volumes, folio. He was known by the title of the Seraphic Doctor; and that his works should have been held in estimation at the abbey of Bonamargy was natural, as we learn from Archdall, who cites Sir James Ware as his authority, that it was built for the Franciscan Friars of the third order, in the fifteenth century. A manuscript list of the Irish Franciscan abbeys, preserved in the British Museum (No. 4814, Plut. cxx. G. p. 2), states that Bonamargy, in the Reuta, was founded in 1500 by Roory M'Quillin, Lord of the Reute. The situation of this abbey is indicated by its name, bun na Mairge, which, as Mr. O'Donovan informs us, signifies the foot, or mouth, of the river Margy, now called usually the Carey river, from its being situated in the barony of that name, anciently Caithrighe, and latinized Cathrigia, by Colgan.

The Rev. William Reeves, in his Ecclesiastical History of Down, Connor, and Dromore (Appendix, p. 285), states that "in Ardagh, a townland in the parish of Ramoan, and barony of Carey, there is a spot called the Friary, whither, it is reported that the brethren of Bonamargy retired upon the dissolution of that house." He further informed Mr. Smith that some stunted cherry trees there still mark the site of their abode, and that the tradition of their residence is distinct in that neighbourhood. By them it seems probable this manuscript was preserved.

It appears to be an amplification of the scriptural narrative of the life of our Lord Jesus Christ. Some curious legends and traditions are interwoven, such as an account of the origin and growth of the tree from which the cross was made, the recovery of his sight by the soldier who pierced our Lord's side, and some other passages.

That there was no intention of imposing this narrative on the readers or hearers of it as the genuine Scriptures of the Gospel, is clear from the reference to the latter at page 5, column 2, where it is said:

"Furthermore he comaunded hem to kepe wel hise comaundementys yn alle thyngis, and sayde to hem, gif ye lovith me kepith my comaundementis. And moo other thyngis he sayde to hem thereof, as it foleweth yn the text."

And again, at page 15, column 2, where it is said of our Lord:

"He was nevere ydell, but spak and taugt helpfull thyngis for us, for he sayde sevene wordys" (while on the cross) "which we fynde yn the gospell."

At page 26, column 2, after stating that our Lord appeared to his disciples and others fourteen times after his resurrection, it is added:

"Neverthelates ye shull understonde that yn the gospel buth but x. apperynges. For that he apperede to his moder ys not yn the gospel, nevere thelates yn the legende it is y sey of the resurreccioun yn diverse places. And that he apperede to Joseph of Arimathie, it is y radde yn the passion of Nichodemus. And that he apperede to James, the same apostle hym silf dyde write to the Corynthyos, and Jerom tellith it also.

"Of the apperynge to $\overset{c}{\text{v}}$." (five hundred) "brethren the apostle writeth there of. And all the other apperynges buth y wrete yn the Gospel. And furthermore thou mast well bethynke, and sooth it is that oure blyssid lord oftetyme visited his moder, and hise disciples, and Mawdeleyne, comfortynge hem, whiche were feruentliche sory of his passioun. And that felyd weel Seynt Austyn seyenge of the tyme aftre his resurreccioun."

Other references to commentaries and sermons of Saint Austin (or Augustin) occur at page 4, column 2, and page 28, column 2, where the writings of Saint Gregory are also referred to.

This manuscript may have been used as a lectionary in the abbey of Bonamargy; but it would not appear that the words "hora vesperarum," and "hora completorium," which occur in red letters at pages 17 and 18, are intended to indicate the portions to be read at those hours. They rather seem to have reference to the passages in the narrative which they follow, the first occurring after the death of our Lord, where it is said, "and it neyzed faste toward eve;" and the other where it is related, as night came on, his body was taken down from the cross.

With the exception of the first page, where the writing has been partially obliterated by damp, the manuscript is in a perfect condition, and must be regarded as a most interesting specimen of the grammatical construction and spelling of the language at the time it was written, as well as of the pictorial and caligraphic skill of a monastic scribe.

Mr. M. Donovan read a paper on the Identity of Malic and Sorbic Acids.

"Previously to my entering on the ultimate object of the present communication, I hope to be excused for making some observations on the discovery of the sorbic acid which I made many years since. In asserting my claim, and soliciting the attention of the Academy to that discovery, which has not been justly dealt with, I hope I shall not be deemed guilty of egotism altogether inexcusable. The rewards of the chemist are few; none but persons engaged in his pursuits can appreciate his toils and his disappointments. The least that can be accorded to him is the acknowledgment of his labours; for in the same proportion that we respect the opinion of the world we value its approbation.

"In the year 1785, the illustrious Scheele, having made a chemical examination of the juices of several fruits, announced the existence of a new and peculiar acid in gooseberries. Obtaining it afterwards in greater abundance from apples, he named it malic acid, and published an account of its properties, of many of its combinations, and of its preparation. Amongst other fruits, he found this acid in the berries of the

Sorbus aucuparia, or, as it is commonly called in Ireland, the mountain-ash tree. He also stated that malic acid can be formed artificially by the action of nitric acid on sugar in a certain ratio.

"In this state Scheele's discovery remained for thirty years, viz., until 1815; and about that period I made experiments on the juice of the berries of the *Sorbus aucuparia*. In the course of this investigation, so many facts presented themselves, which disagreed with the statements of Scheele, that I began to doubt the existence of malic acid in these berries; and at length came to the conclusion that the acid contained in them is essentially different. I contrived a process for preparing the new acid, which, from its source, I named sorbic, and formed many combinations with it which differed altogether in their properties from the analagous compounds prepared with Scheele's malic acid.

"I found that the same acid is contained in apples and some other fruits; and as in all these Scheele had ascertained the presence of malic acid, I inferred that two acids exist in these fruits, the sorbic being a distinct and peculiar one which had escaped his observation. I was strengthened in this conviction by finding that the malic acid, furnished by the plant *Sempervivum tectorum* or houseleek, which Vauquelin proved to contain malate of lime, evinced, when combined with bases, habitudes quite different from those of the new acid. My conclusion was still further confirmed by observing that the acid produced by the action of nitric acid on sugar, which Scheele pronounced to be malic, could not by any means be made to furnish combinations similar to those of sorbic acid; that it was in fact totally different, as has since been proved by the researches of chemists. I therefore presented to the Royal Society of London a paper 'On the Nature and Combinations of a newly discovered Vegetable Acid,' &c., which was published in the Philosophical Transactions for 1815: the sorbic acid was admitted into the list of vegetable acids in all systems of chemistry published at that period.

"In two years after (1817) M. Braconnot, a celebrated continental chemist, read a paper in the Royal Society of Nancy, on sorbic acid, which was published in the Annales de Chimie et de Physique (vol. vi. p. 239). In this communication he expressed his opinion that sorbic acid is different from malic and all others. He gave an economical process for preparing it, and described many of its combinations and their constitution.

"In the same year M. Vauquelin published experiments on this subject, in the same volume of the Annales de Chimie et de Physique (p. 337). He, as well as Braconnot, admitted the sorbic acid to be a new and peculiar one; and declared, as the result of his inquiries, that malic acid, so far from being the only and proper acid of the berry of the *Sorbus aucuparia*, as Scheele had supposed, is not present in that fruit, he having found in it no other than the sorbic. He adopted the process given by me for preparing sorbic acid; described some of its properties and combinations, along with their analysis.

"Braconnot, who at first admitted the sorbic to be a new acid, had, meanwhile, continued his investigations, and in 1818 announced some new facts which had caused him to modify his opinions. His paper was read in the Royal Academy of Sciences, and published in the eighth volume of the Annales de Chimie et de Physique (p. 149). In this paper he described a vegetable proximate principle, detected by him in the juice of the houseleek plant, which he conceived to hold a middle place between gum and sugar, and which possesses so powerful an influence in masking the combinations formed by sorbic acid that a sorbate of lead containing a very small quantity of it refused to crystallize. He adds: 'I believe I may conclude from my experiments that the malic acid of Scheele is composed of at least two substances, viz., sorbic acid, and this abundant mucous matter, which is not always of the same nature. It remains to examine, with more care than has hitherto been done, the numerous variety of impure acids which have been comprised in a great number of analyses, under the name of malic acid; it is probable that we will find in them sorbic acid, and perhaps some *other new* acids masked by this mucous principle. I am at present satisfied in the conviction of the complex nature of the malic acid obtained from the principal substances in which it is indicated, as apples, houseleek, sorbus berries, and grapes.' Elsewhere (p. 150) he says that the malic acid of Scheele contains abundant foreign matter, 'which completely masks all its properties.' From this extract we may infer it to be the opinion of Braconnot that sorbic acid is a different substance from the malic acid of Scheele, and that the latter should not be considered as a distinct acid, inasmuch as it is a compound of an acid with a large quantity of another vegetable proximate principle; and we know that both are combined by so powerful an affinity that difficult processes are necessary for their separation.

"In my paper, published in the Philosophical Transactions, I laid claim to the discovery of a new vegetable acid, possessing properties and forming combinations quite different from those of Scheele's acid. That I established my claim was not disputed, either professedly or incidentally by the subsequent researches of Braconnot or Vauquelin. The difference between Scheele's acid and mine is so great that each was deemed *sui generis* until Braconnot's discovery of the mucous disguise. Scheele represented his malate of lead as a precipitate; the sorbate of lead consists of strikingly beautiful crystals: his malate of potash, malate of soda, and malate of ammonia, are all uncrystallizable and deliquescent; the sorbates of these bases are all capable of furnishing crystals which do not deliquesce: his malate of magnesia is a deliquescent mass; but sorbate of magnesia is a crystallizable salt which is permanent in the air. Thus none of the malates, as described by

Scheele, bore the characters of the true salts, nor did the acid itself represent the true acid; it was even confounded by him with that produced by the action of nitric acid on sugar.

"It is true I did not perceive that sorbic acid is crystallizable, which is not to be wondered at, inasmuch as it is deliquescent; and, even if crystallized, it would, when exposed, soon return to the syrupy consistence in which I obtained it.

"Yet the editors of the Annales de Chimie et de Physique, who at that time were MM. Gay-Lussac and Arago, observing on Braconnot's experiments, give the following opinion: 'If it be incontestable that malic and sorbic acids are identical, justice demands that we should retain the name of malic acid given by the illustrious Scheele to the acid which he discovered in apples.' This is very nearly tantamount to conveying the opinion that Scheele should be considered the discoverer of sorbic acid; and if such a mode of reasoning be legitimate, then he who first made wine ought to be considered the discoverer of alcohol, and Noah would bear away honours which were earned by one who lived 3000 years after him. Admiration of transcendant talents should not extinguish justice; the splendour of Scheele's discoveries needs not the additional glimmer of a taper. Scheele attributed to his masked and insulated acid properties essentially different from those of the sorbic. Without the aid of his discovery, I must at length have arrived at the knowledge of the sorbic acid, as my experiments were made on a different fruit; and his inquiry, so far from aiding mine, tended greatly to embarrass it, by leading to the belief that the sorbus berries and other fruits contain another acid beside that one which I obtained. In reality, this celebrated chemist failed to discover the acid of either gooseberries, apples, or sorbs; and as the motive of giving the name of malic acid to the compound obtained by him was, that he procured it with greater facility from apples than gooseberries, the same motive, if there were no other, should cause it to be named sorbic acid, as it is so much more easily and abundantly obtained from sorbs, that no chemist ever thinks of preparing it from any other source. The suggestion of the Editors of the Annales de Chimie has not been without its effect. The authors of most of the systems of chemistry have retained the name ‘malic acid,’ and allude to me as one who had fallen into error with regard to its nature, instead of representing me as its real discoverer.

“The editors of the Annales de Chimie, &c., have made another observation which ought here to be noticed: they say: ‘The experiments of M. Braconnot leave no doubt that the acid of houseleek, and *consequently* that of apples, are the same as that from sorbus berries.’ Now, let us inquire what these experiments were. In Braconnot's first paper he admits that sorbic acid is a new one, different from Scheele's malic acid; he quotes my process for preparing the former, and analyzes several of its compounds. In his second paper he recounts a series of experiments on the juice of houseleek, his object being to procure pure malic acid. But during these efforts he discovered the above-mentioned mucous matter which possesses the power of masking the properties of the acid; and having found means of detecting it, he ascertained that the acid thus purified agrees, in all its properties, with the sorbic acid, contrarily to the opinion of Vauquelin, reiterated by me, that houseleek contains nothing but Scheele's malic acid. He concludes with a description of the properties of the brown mucous matter. This is the whole substance of M. Braconnot's two papers. I do not perceive how they leave no doubt that the acid of houseleek, for it was on that he experimented, ‘and *consequently* that of apples,’ are the same as that from the sorbus berries. Braconnot described no experiments on the acid of apples; his object was to show that the acid of houseleek possesses properties which are also exhibited by the acid found by me both in apples and in sorbus berries, thereby proving that sorbic acid may be derived from these three sources, but by no means affording any evidence that apple-acid and sorb-acid are the same, or that apples contain no other acid. Vauquelin, it is true, ineffectually sought Scheele's acid in sorbus berries; but neither he nor Braconnot made trial of apples. The question of identity was therefore left undecided: it was still possible that malic acid, such as Scheele described, might exist in apples, along with sorbic, inasmuch as no experiments have hitherto been published which directly disprove his statements. Under these circumstances of doubt, I thought it right to undertake the inquiry; and I now purpose to adduce facts which will supply what was deficient in our means of determining the question.

" When the juice of unripe apples is mixed with solution of acetate of lead, a curdy precipitate separates abundantly. If this be filtered off, and boiling water be allowed to run through it, the water as it passes being received in a number of vessels, it will be found that crystals will sooner or later form in several of the first vessels, and none in the last: nor will any further affusions of boiling water on the pasty mass remaining on the filter furnish a single crystal. In order to obtain a further product of crystals, the pasty mass must be decomposed by dilute sulphuric acid; the sulphate of lead is to be washed with much water, the whole to be filtered, and the clear liquor again mixed with solution of acetate of lead, which will cause a new precipitation. The precipitate, filtered off, is to be treated as before with boiling water, and the liquor received in different vessels. Crystals will form in the first vessels, and none in the last. The pasty mass is still capable of furnishing crystals by a repetition of these processes. No one before me had ever procured these crystals from apple-juice; their properties had never been investigated; the extent to which, by repetition of the foregoing processes, crystals could be produced, had never been ascertained; and, consequently, it was not known whether the whole mass is convertable into crystals, or whether a portion of it would remain uncrystallizable, which might contain an acid corresponding with the properties that Scheele had assigned to his malic acid. This was the grand question, and conceiving that, until it be determined, the presumed identity of sorbic and malic acids is a premature and unwarrantable assumption, I undertook the inquiry in the following manner:

"A quantity of unripe apples, sufficient to afford four gallons of juice, were crushed to a pulp, and subjected to the action of a screw-press. The juice, after standing twenty-four hours, was poured off the fæces, boiled, and strained. To this was added solution of acetate of lead while any precipitation ensued; the precipitate was filtered off, and allowed to drain for several days. It was then boiled, for five minutes, in two gallons of water, and the liquor was filtered while very hot. The remaining mass was again boiled in two gallons of water, and the hot liquor filtered. The boiling and filtration were repeated until both processes were performed in all six times. In the first four waters, crystals appeared after twenty-four or forty hours; in the last two there were none. The matter which remained undissolved on the filter, now incapable of furnishing crystals, was decomposed by a slight excess of very dilute sulphuric acid; and, everything soluble being washed out of the sulphate of lead, all the washings were collected, filtered, and mixed with a new portion of solution of acetate of lead. The precipitate thus produced was separated by the filter, allowed to drain well, and after being boiled in two gallons of the water which had been used in the former processes, the liquor was filtered. The pasty mass remaining on the filter was again boiled in two other gallons of the former water, and the solution filtered. This boiling in new portions of the original water, and filtering, were repeated in all six times. In each of the first four waters, after forty hours, beautiful white crystals were formed; but little in the fifth, and none in the sixth. These processes of decomposition by sulphuric acid, recomposition by acetate of lead, boiling in divided waters, filtering, and crystallizing were repeated until the original precipitate from the apple-juice, by acetate of lead, was reduced to a mere trifle; new water having been, in all cases, added to compensate the loss by evaporation. As it is my intention to resume the subject hereafter, it is not necessary, in this place, to assign a reason for the several decompositions of the precipitate with sulphuric acid, and its recomposition with acetate of lead: it is enough to say that, without these processes, the mass cannot be converted into crystals.

" Thus the whole of the original precipitate was dissolved in water; almost the whole of it crystallized, but a small portion remained in solution. The mother-waters were therefore evaporated down to one-sixth, and set by to cool: a dark-coloured precipitate, mixed with irregular crystals, was deposited, which, by other processes, was made to furnish crystals like the former. Further evaporation and similar treatment afforded a little more crystallized matter. In short, the whole of the original precipitate from apple-juice and acetate of lead was converted into crystals, except a very small portion which appeared to be neutral vegetable matter, mixed with earthy salts from the water evaporated.

" The crystals were sorbate of lead; mere inspection by an eye familiarized to their striking appearance was sufficient to determine their nature. But, to put the matter beyond doubt, I decomposed the whole crop first by means of an insufficient quantity of sulphuric acid, and lastly by an excess of sulphuretted hydrogen. The acid thus insulated proved by its habitudes with lime, potash, soda, and magnesia, to be sorbic acid; and in this manner *the whole of the acid which exists in apples* was demonstrated to be the same as that which imparts acidity to the berries of the *Sorbus aucuparia*, a position which had been only previously assumed.

" To conclude: the objects of the foregoing statements have been, 1st, to establish my claim to the discovery of sorbic acid; 2nd, to show that Scheele's so-named malic acid, which has been confounded with the sorbic, was not an acid *sui ge-*

neris, but a compound altogether different in its nature and properties; 3rd, to prove that the supposed identity of sorbic acid with Scheele's acid of apples was assumed on insufficient grounds; and 4th, now, for the first time, to supply the hitherto deficient evidence that the acid of apples is the same as that of sorbus berries, neither containing any other acid than the sorbic."

Rev. Charles Graves communicated some notes made by himself and Mr. Charles M'Donnell respecting the existence of various manuscripts in Ireland in the early part of the seventeenth century.

Rev. Dr. Todd presented rubbings from the monumental stones in the churchyard of the abbey of Dungiven, Co. Derry.

APRIL 22ND, 1850.

The REV. HUMPHREY LLOYD, D. D., PRESIDENT, in the Chair.

The Secretary read the following second Report relative to the establishment of a system of meteorological and tidal observations in Ireland:

"In presenting to the Academy their Second Report relative to the establishment of a system of Meteorological and Tidal Observations in Ireland, your Council desire to state that they have given their earnest and attentive consideration to the details of the proposed measure, and especially to the plan of observation required. Before entering upon the latter, it will be necessary to advert briefly to the nature of the questions whose solution is sought. In Meteorology the following are the principal:

"1. The distribution of temperature, humidity, and rain, as affected by geographical position and by local circumstances; and the other phenomena of climate.

"2. The effect of season (combined with the influences already referred to) upon the distribution of temperature, and the varying position of the isothermal lines *from month to month*.

"3. The *non-periodic* variations of pressure, temperature, and humidity, and their connexion with the course and direction of the aerial currents.

"4. The phenomena and laws of storms, whether revolving or otherwise.

"5. The periodical winds prevailing during certain seasons, and their modifications from geographical position or local causes.

"6. The course and rate of progress of atmospheric waves.

"The chief conditions for the solution of these questions are, that the observations should be taken *at equal intervals* of time, at a sufficient number of well-selected stations, and that the times should be chosen in such a manner as to furnish the *daily means* of the elements sought. But it has been shown that *any two* observations in the day, taken at equal intervals, are sufficient to eliminate the diurnal variation, and to give the daily means of all the meteorological elements, excepting the atmospheric pressure; and, as the diurnal variation of the pressure is very small in these latitudes, —much smaller than the irregular fluctuations of the same element, the objects for which the present system is instituted will be best attained, by taking *two* observations in the day, at *homonymous hours*.

"The best pair of homonymous hours, all circumstances considered, is 9 A. M. and 9 P. M., mean time of the place of observation; and these are accordingly proposed as the fixed hours of observation for those who co-operate in the present system. In order to elucidate more fully some of the questions above noticed, and in particular that which relates to the movements of atmospheric waves, it is proposed also, that *hourly observations* should be made at all the stations for twenty-four hours, four times in the year, namely, at the equinoxes and solstices. *Occasional* hourly observations will likewise be made under special circumstances.

"As respects the second head of inquiry,—namely, the phenomena and laws of the Tides on the coasts of Ireland,—the more important questions that present themselves, as demanding further investigation, are the following:

"1. The law of the *diurnal* tide, referred to the actions of the two luminaries, and the separation of the effects due to each.

"2. The apparent anomalies in the progress of the diurnal tide-wave, and the variations of its range.

"3. The phenomena connected with the progress of the *semi-diurnal* tide-wave in the Irish Channel, and its supposed inversion.

"4. The proof from observation of the existence of a *tertio-diurnal* tide, as indicated by theory.

"5. The apparent difference in the heights of mean water, on the north and south coasts of the Island, as well as in large and small tides.

"Owing to the complexity in the law of the rise and fall of the tide, and its variations at different places, the system of observation required in the solution of these questions is necessarily an elaborate one. The whole course of the tide must be followed, by observations at short intervals; but, as so great an amount of labour could not be expected continuously, it is proposed that the *four principal tides* in each lunation only (the two *spring* and two *neap* tides) shall be observed in this manner,—the observations being continued at intervals of a quarter of an hour for twelve hours. In addition to these *weekly* observations, *daily* observations of the greatest and least heights of the tide (without reference to *time*) will be obtained by the help of a self-registering apparatus.

"Your Council have prepared a body of instructions, based upon the foregoing principles, in which the rules as to the times, and all the other details of the method of observation, are fully explained.

"The instruments required at each station for these investigations are, a barometer, a pair of ordinary thermometers (dry and wet bulb), a pair of self-registering thermometers, a wind vane, Lind's anemometer, and a rain-gauge. In addition to these, a self-registering tide-gauge will be required at the tidal stations, and a thermometer adapted to the observation of the temperature of the sea. The details connected with the form and construction of these instruments have been fully considered by the Committee of Science;

and it is proposed that they shall be as simple and inexpensive as is consistent with accuracy. An estimate for the meteorological instruments, furnished by Mr. Yeates, has been submitted to your Council and approved of, from which it appears that the cost of a complete set will not exceed £10.

"Your Council have the gratification of stating, that the application to the Lords of the Treasury, requesting that they would direct the required observations to be made by the officers of the Coast-guard, at certain stations round the coasts of Ireland, has been promptly acceded to; and that a communication has been opened with the Comptroller-General of the Coast-guard on the subject. Orders have, in consequence, been issued by the Comptroller-General to the officers in command of the several districts, directing that the views of the Council be fully carried out.

"The Coast-guard stations, selected by the Committee of Science, and approved of by the Council, are the following: Kingstown, Courtown, Dunmore, Castletownsend, Valentia, Kilrush, Old Head, Mullaghmore, Buncrana, Ballycastle, Donaghadee, and Ardglass. It may be necessary to observe, that the offer of the Academy to supply instruments has reference to these stations only. All other parties co-operating will be expected to procure their own instruments, if they do not already possess them; but the Council will gladly give any assistance which may be required, either in directing the choice of the instruments, or in verifying and comparing them when obtained.

"Promises of co-operation have been received from the Board of Trinity College, from the Warden and Fellows of the College of St. Columba, and from the Board of Works; as also from the Earl of Rosse, Dr. Robinson, and Mr. Cooper. From the other parties applied to no official replies have been as yet received.

"Your Council have reason to believe that there are, moreover, many private individuals in Ireland who are already engaged in making Meteorological Observations, and others who would engage in them, provided that a definite object of inquiry were set before them, and that they had the stimulus which association imparts to those who are united in a common pursuit. They have, accordingly, addressed a circular letter to such persons, inviting their co-operation; and to this letter has been appended a statement, setting forth the objects of the proposed organization.

"Your Council have only to add their expectation, that the preliminary arrangements will be completed in two months from the present time, and that the regular series of observations may be commenced on the 1st of July."

The President communicated some notes on the storm which visited Dublin on the 18th April last.

"Having watched attentively the progress of the late storm from a favourable position, and collected some facts relative to it from the records of the Observatory, and from other sources, I avail myself of the present opportunity to lay them before the Academy. The phenomena were of a nature so unusual (I may say unexampled) in these climates, that it is desirable that some notice of them, however imperfect, should be placed on record; and the present summary of facts is offered, chiefly in the hope that it may serve as a nucleus to a more complete one. I shall limit myself, mainly, to those which have an immediate scientific bearing.

"The morning of the 18th was fine in Dublin, with bright sunshine, light cirrous clouds being scattered loosely over the sky; at ten o'clock these became diffused, and the sky was evenly, but lightly overcast.

"From the tracings of the self-registering anemometer, erected in Trinity College, it appears that on the 17th, and during the morning of the 18th, the wind blew gently from the south-west. Towards noon, on the latter day, it gradually veered to the south, and continued at that point until the arrival of the storm. This veering of the wind, however, appears to have been confined to the lower current; the direction of the upper current, as estimated by the motion of the clouds, appeared to be nearly south-west.

"The first indications of the approach of the storm were observed soon after three o'clock. Massive *cumuli* were seen in the western and south-western portion of the horizon. These became denser as they approached, until they formed a mass of an ash-grey colour, projected on a sky of a paler tint, while the rugged outliers from the mass, of the peculiar form which indicates a high degree of electrical tension, showed plainly that a storm was approaching. About half-past three o'clock it burst forth. The flashes of lightning (generally forked) succeeded one another with rapidity, and at length the roar of the thunder seemed continuous. Some persons who observed the phenomena from a distance were able to distinguish the two strata of oppositely electrical clouds, and to see the electrical discharges passing between them.

"Hitherto the wind was light, and there was that peculiar closeness in the air which is the result of high temperature and excessive humidity. Shortly before four o'clock the rain commenced; this was followed almost immediately by discharges of hail, and at four, P. M., the terrific tornado, which was the grand and peculiar feature of this storm, reached us.

"This gale, which appears to have been a true whirlwind, first sprung up from the south-east, driving the hail before it impetuously. It then suddenly, and apparently in an instant, shifted to the point of the compass diametrically opposite, and blew with increased violence from the north-west. The noise about this time of the shifting of the wind was terrific, and arose (as is conjectured respecting similar tropical phenomena) from the confused conflict of hail in the air. The size of the hailstones, as well as the vehemence of the gale, appeared to be greater during the second phase of the storm than the first. These masses, many of which were as large as a pigeon's egg, were formed of a nucleus of snow or sleet, surrounded by transparent ice, and this again was succeeded by an opaque white layer, followed by a second coating of ice. In some of them I counted five alternations.

"In less than ten minutes the tornado had passed. The wind returned to a gentle breeze from the south-west, the clouds dispersed, and the weather became beautiful. All the phenomena,—the direction of the gale perpendicular to that in which the storm-cloud was advancing, and the sudden reversal of that direction,—seem to prove that it was a tornado, whose centre passed directly over the place of observation. It is evident, on comparing the direction of the wind when the whirl first reached this part of the town, with that of the progressive motion of the vortex itself, that its rotatory motion was *retrograde*, or in an opposite direction to that of the hands of a watch with its face upward. It is deserving of notice also, that in the northern hemisphere this is the invariable direction of the *cyclones*, or great revolving storms, to which the attention of meteorologists has been directed by Colonel Reid and Mr. Redfield. The late storm was, however, different from a cyclone, both in the dimensions of the vortex and in the causes from which it originated. The horizontal section of the cyclone where it meets the earth is often 500 miles in diameter; and the vortex is supposed to be the effect of two crossing currents of air, which generate a movement of rotation. In the tornado (to which species the late storm belonged) the vortex is of much smaller dimensions, and is produced by rapidly ascending currents of air, caused by the heating of a limited portion of the earth's surface under the action of the sun's rays. In the temperate zones, accordingly, it is never produced in winter.

"The evidence relating to the direction of the gale, and its changes, as it passed over the College Park, is very complete and satisfactory. In the park, and garden adjoining, nineteen trees were rooted up and prostrated; eleven of them being trees of large size. Of these ten have fallen from the south-east, or under the action of the first half of the gale, and nine from the north-west. Their bearings have been accurately taken; and the general result is, that the mean direction of the south-east gale, as indicated by that of the trees, is S. 56° E., and that of the north-west gale N. 53° W.

I believe that these results are even more accurate than those furnished by the anemometer; and they prove that in this locality the direction of the wind was exactly reversed, and, therefore, that the centre of the vortex passed over the College.

"A remarkable circumstance connected with the direction of the fallen trees is their great uniformity, the individual directions seldom differing more than 10° from the mean. This is an indirect evidence of the great violence of the gale; and it proves, moreover, that the transition from the south-east to the north-west wind was immediate. There is greater regularity in the direction of the trees fallen from the north-west than in those which have been blown down from the opposite quarter. This may have arisen partly from the greater violence of the gale in the former direction; but it is partly also due to the circumstance that the trees which fell from the north-west are generally larger and in a less inclosed portion of the ground. It may be mentioned also, that the trees which fell from the north-west generally lie to the southward of the others; there are, however, two large trees in the garden lying *side by side*, but in directions diametrically *opposed.*

"It has been stated that in the College Park the shifting of the wind amounted to 180°; and it has been inferred that the centre of the vortex passed over that spot. From what has been said as to the nature of the phenomenon, it will follow that in other localities, over which the vortex did not pass centrally, the wind must have shifted through different points of the compass, and through angles smaller in proportion to their distances from the centre. Thus, on the southern side of the line described by the centre of the vortex, the change of the wind should be from *south to west*, and on the northern side of the same line from *east to north*. We are not yet in possession of facts which bear upon this point; but from the limited dimensions of the vortex, and the consequent smallness of the distance necessary to produce such a variation, it is probable that evidence bearing upon it may be obtained. I shall only observe that, in seeking and comparing such evidence, care must be taken not to confound *eddies* arising from local obstructions with the general direction of the current.

"The hours of observation at the Magnetical Observatory are 7 A. M., 10, 1 P. M., 4, 7, 10. The observations of the barometer, and of the dry and wet thermometers, made at these hours on the day of the storm, are the following :—

Hour.	Barometer.	Dry Therm.	Wet Therm.
7 A. M.	29.944	49.5	47.4
10	29.952	54.7	50.5
1 P. M.	29.964	58.6	52.0
4	29.930	56.0	52.3
7	29.944	52.6	52.0
10	29.936	51.0	49.6

The fall of rain and melted hail in Trinity College during the storm amounted to 0·596 of an inch; but it is probable that the hail was driven out of the receiver of the gauge by the wind.

"It will be seen that the barometric fluctuation is small. It is stated, however, that a sudden and considerable fall of the barometer took place shortly before the storm. From the observations above given, at 1 and 4, P. M., it will be seen that the barometric equilibrium, if so disturbed, was soon restored.

"I have collected from the newspapers and other sources such information as I could obtain respecting the area of the city visited by the gale, but it is as yet incomplete. It appears, however, that the diameter of the vortex was not very different from the length of the city from north to south; the gale having been limited by the Circular-road in these two directions. Hail fell, however, abundantly beyond the limits of the gale. Thus, at the gardens of the Royal Dublin Society, at Glasnevin, the damage done by the hail was very great; but it was limited to the roofs of the houses, the hail having fallen perpendicularly. The amount of the rain and melted hail registered there was 1·7 inches in 35 minutes.

"Further information is wanting also to enable us to determine exactly the progressive movement of the centre of the vortex. We are informed by the newspapers that a storm similar to that which visited Dublin, although not so severe, took place at Mullingar, about an hour and a half previously. If this be the same storm, the direction of the progressive movement must have been nearly from west to east, and its velocity about thirty miles an hour. This direction accords with that given by the observed limits of the storm on the northern and southern sides of the city; but it seems to have been modified, at the surface of the earth, by the lower current. The velocity of the rotatory movement was, of course, vastly greater than that of the progressive; but we have no direct measure of its amount.

"The damage done in Dublin has been principally in the destruction of glass caused by the hail; but many chimneys have been thrown down, and many roofs dismantled, by the gale. The estimated amount of the loss sustained, as ascertained by the Metropolitan Police, is £27,800. Many houses were struck by the lightning; but, happily, there was no loss of life from that cause.

"There seemed to have been a disturbance of electrical equilibrium, accompanied by rain, in many remote parts of Ireland on the same day."

Mr. Hogan communicated the following additional facts relative to the same phenomenon:

"In tracing the history of the remarkable hurricane of the 18th inst., we must distinguish between the direction of the wind where it was raging, and the prevailing current of air by which it was borne along from place to place. The latter seems to have been a gentle breeze from the west, not strong enough to prevent large hail-stones from falling perpendicularly. The hurricane itself was so violent that the largest trees were in a moment torn out of the ground and prostrated, and the hail was carried about in all directions, —even, in some instances, in opposite directions, in the same street, and at the same moment.

" All the damage done in the lawn of the Royal Dublin Society was by wind from the south-east. In Westmoreland-street it raged from the north-west; and a hand-cart was blown down the street and found inside the iron rails in front of the College, having, most probably, been carried over them. In the College Park trees were blown down by winds from both points, as stated by the President.

" I have been informed by an eye-witness that, during the hurricane, the wind blew violently down the river, and afterwards up the river with equal violence; and that, at the moment when the change of direction took place, he saw some boats, which were moored opposite Bachelor's-walk, lifted out of the water and capsized. I have been also informed, that lower down the river, ships were torn from their moorings, and carried away by the hurricane, which brought them back again when its direction changed. In short, there is abundant evidence that, in Dublin, the wind raged in every direction, and that the centre of the whirlwind passed over it. The hail and rain preceded the hurricane, which was not destructive to the windows until near the time when they ceased. This may account for the fact, that most of the windows were broken by hail coming only from two points of the compass.

" The centre of the whirlwind seems also to have passed over Mr. Journeaux's mill on the south bank of the Grand Canal, due west of Dublin. At this place a cart was carried up into the air, and thrown over a hedge into the Canal, with the shafts downwards, which were deeply imbedded in the bottom. Much damage was also done to the buildings of the mill.

"The centre of the hurricane also passed over Mount Armstrong, in the county of Kildare, the residence of Christopher Rynd, Esq., about eighteen miles due west of Dublin. I was at his house on the 19th of April, and saw the devastation committed on all sides of his premises, as well as the bare walls of an out-office, from which the roof had been carried in one mass into the air, and then dashed to the earth at a distance of 200 yards. The following is the substance of a written account of the occurrence by Mr. Rynd :

"'The first appearance of change of weather was from distant thunder, and occasional flashes of lightning, at a quarter past 3 P. M. This continued about a quarter of an hour, when suddenly a terrific hail storm commenced, and lasted about ten minutes. Before it ceased a frightful rushing sound, like the escape of steam from a large steam engine, was heard; and then, just as the hail ceased, the hurricane commenced. My yard of offices and house form a perfect square, and, to the best of my belief, every side was simultaneously attacked; and one large new roof (indeed they were all new) was completely raised in a mass,—timber, ton-slates, and wall-plate,—and carried 200 yards into a field. There was no storm of wind at 300 yards on either side; it travelled in a narrow space, and caused no other damage worthy of notice in my neighbourhood.'"

Mr. Donovan read the following paper on the position in society of physicians amongst the Greeks and Romans:

"The condition of the physicians of ancient Greece and Rome has been a subject of controversy amongst writers on medical antiquities, some maintaining that they were all slaves, while others were of opinion that a limited number only were of the servile class. A passage in Suetonius' Life of Julius Cæsar has given occasion to his commentators to open the question; and some learned physicians, for the honour of their profession, have discussed it more extensively, and with much greater effect.

The passage is as follows: ‘Cæsar, having been captured by pirates near the island of Pharmacusa, was detained by them for forty days, with one physician and two servants; for he had sent away his companions and his other slaves to obtain money for his ransom.’ The words in the old copies are ‘cum uno medico et cubiculariis duobus.’ Plutarch, in alluding to the circumstance, calls the physician the friend (φιλον) of Cæsar; on which account, Robertellus altered the text from ‘uno medico’ to ‘uno amico,’ assigning as his reason that the physicians of Rome were slaves, and that therefore it was improbable that Cæsar would cultivate or permit an intimacy with one of that condition. Cæsar, however, might have been of the opinion of Epicurus and Seneca, that slaves are no other than friends of a more humble class. Eudemus is called, by Tacitus, the physician and friend of Livia. But Philippus Beroaldus adopted the correction, and also the statement that ‘in ancient times the physicians were amongst the number of slaves:’ he says that ‘competent authorities have decided the point, and chiefly Seneca.’ Several others, on the same authorities, have arrived at the same conclusion; amongst whom may be numbered J. J. Hoffman (Lex.), Forcellini, and Facciolati (Lex.), and C. F. Hermann. On the other hand, the learned Casaubon, commenting on the reading of Robertellus, says: ‘In the first place, it is false that all who then professed medicine at Rome were slaves; many Greeks, excelling in that art, frequented Rome for the profitable practice of their profession; some of them having been rendered free, and others being not only free themselves, but the sons of freemen (*ingenui*).’ ‘It is most false that the physicians were not received in the relation of friends by the Roman magnates.’ He then gives instances where they were admitted to the friendship of emperors.

“The object of Casaubon being merely to restore what he conceived to be the true reading of his author, he has not brought forward the evidences which were within his reach, for the purpose of defending the profession of medicine against the stigma of a degrading origin. And although Le Clerc and Drelincourt have undertaken that task, aided by an unusual share of erudition, they have not exhausted the subject. It is the object of the present communication to adduce a few additional considerations.

"During the earliest periods, medicine was, no doubt, cultivated in the East, along with other sciences; was thence imported into Egypt, and soon became a part of the studies of the priests. As the records of all remarkable cures were deposited in their temples, they had opportunities of acquiring medical knowledge, and they frequently used it with good effect. The ancient Egyptians were more than any other nation addicted to the care of health, which gave occasion to the sneer of Herodotus, that they were all physicians: but Diodorus Siculus says that no one dare publicly profess medicine unless admitted into the order of priests. That there were servile persons, however, who dabbled in medicine, appears from holy writ: 'And Joseph commanded his servants the physicians to embalm his father.'

"Amongst other nations of antiquity, there were neither physicians nor an acknowledged code of medicine, nor did the priests interfere in medical affairs. Whatever knowledge of remedies existed was diffused amongst the population, and this, when necessity required, was rendered available in the following singular manner: 'The Babylonians' (says Herodotus) 'have no physicians by profession, but those who are diseased, being brought into the public places, whoever passes the sick man advises with him concerning his disorder, and if he has himself, at any time, laboured under the same complaint, or known one affected in the same way, recommends the remedies by which he himself or others were cured. To pass a sick person without inquiring his complaint is deemed a breach of duty.' The splendid city which could boast of a hundred brazen gates could not produce one physician.

"The same usage obtained in Egypt and at Rome. In the latter place, it was the practice to carry the sick to the forum, in order that the opinion of passengers might be taken on his case; but this practice gave way to a different one.

"In subsequent times, it was the custom of wealthy persons, in Greece and Rome, to employ such a vast number of slaves that Seneca compares them to armies; and he describes the duties of some of them to be of a disgusting character. Amongst the most useful of the functions performed by slaves were those of physicians, surgeons, and compounders of medicine; many such are mentioned by the ancient Roman and Greek writers, a few examples of which it may be proper to cite. Suetonius, speaking of Domitius, the fourth ancestor of Nero, says, that having taken poison in his despair, he so much feared the death which he had previously sought, that he discharged the poison from his stomach, and rewarded with his freedom the physician who had so skilfully and prudently rendered it innoxious. Seneca tells the same thing more plainly; he says, 'Domitius commanded his slave, who was also his physician, to give him poison (medico eidemque servo suo).' Suetonius quotes an epistle of Augustus to Agrippina, in which he says, 'I send you also one of my slaves, who is a physician.' Pliny the younger was cured of a dangerous disease by Harpocras, whom he expressly describes as 'a slave, although a physician.'

"We have also a proof in Cicero's Oration for King Deiotarus, who was accused of an attempt to procure the assassination of Julius Cæsar, on the evidence of one Phidippus, whom Cicero declares to have been the physician as well as the slave of the king. There is a passage in Diogenes Laertius, which proves not only the identity of the slave with the physician, but alludes to the purchase of such a physician.' Diogenes the Cynic, being offered for sale as a slave, was purchased by Xeniades. Diogenes, in his usual insolent manner, said to his new master, 'See that you do what I order you.'

His master answered by a trivial quotation, to which Diogenes replied: 'If you, being sick, were buying a physician, would you have so answered?'—'A physician, although a slave, certainly ought to be obeyed.' Of the words made use of, ιατρος and δουλος, applied to the same individual, there can be no misconception. Paulus Orosius has been quoted to prove that all physicians at Rome were slaves; but without reason, for he evidently copied from Suetonius, and by his collocation of the words has perverted the sense. Orosius, therefore, is not an authority.

"Thus in Greece and Rome, for at least four centuries, it is a well-attested fact, that slave physicians were maintained in families. The greatest confidence was sometimes reposed in them, even by crowned heads. The Emperor Augustus had a physician named Antonius Musa, who had been his slave, and to his care he intrusted himself when, as Suetonius informs us, he was 'distillationibus jocinere vitiato ad desperationem redactus;' which probably means that his disease was a vitiated secretion of the liver, although Pliny says it was inflammation of the bowels. Musa, finding that warm fomentations did not succeed, tried cold baths, and gave him cold water draughts, all of which, we learn from Suetonius and Celsus, was considered a dangerous experiment. He also ordered his royal patient to eat lettuces. Augustus submitted, such was his confidence in his former slave's skill, and he recovered. Musa was rewarded with much wealth; was honoured by the Senate with a brazen statue placed near that of Esculapius; was permitted to wear a gold ring, which none were hitherto entitled to the use of but magistrates and those persons called 'ingenui;' and for his sake the same permission was granted to all persons exercising the medical art in the city. Such were his rewards for a prescription of lettuces and cold water. He practised the same treatment on Horace, who survived; but another patient, Marcellus, was killed by the experiment.* It is a curious example of the kind of practice employed by the slave physicians.

"There can be no doubt that Rome and Greece abounded in these humble practitioners; and although the healing art was, in this respect, a servile occupation, it was held in high estimation. Plutarch's encomium on it was, that 'it is second to none of the other liberal arts in wealth, splendour, or enjoyment; it liberally bestows on its cultivators good health and a sound constitution.' M. Cato respected physic but despised physicians, and did not employ them; he wrote a medical treatise for his family, and treated their diseases himself.

"But, beside these slaves, we find Greek and Roman physicians mentioned in ancient history, who certainly had never been of the servile class, and who maintained the highest rank as citizens. Pliny has given an account of a succession of physicians who practised in Rome, but he never once alludes to their having been slaves; although the abhorrence in which he held the medical tribe would certainly have induced him to say anything to their disparagement that truth warranted. The regular physicians were of such rank in their profession, that they derived considerable incomes from their practice; some were entitled to draw from the public exchequer annually to the amount of 250,000 sesterces, or £2010 of our money. Quintus Stertinius, a physician, complained of the emperors whom he served, for allowing him but 500,000 sesterces, or £4020 a year, while he received from private individuals in the city, who retained him as their medical adviser, 600,000 sesterces, or £5824 per annum. His brother received a similar sum from Claudius Cæsar. The two brothers bequeathed to their heirs no less than 30,000,000 sesterces, or £291,200. A physician named Charmis stipulated, for the case of one patient, to be paid 200,000 sesterces, or £1941. Erasistratus, being consulted on the case of Antiochus Soter, received 100 talents, which in Syrian money would be equal to £387 5s. 10d. of our's. It need scarcely be observed, that such men as these could not have been slaves. We have a very different account of a physician's fee in some verses preserved by Diogenes Laertius, where it is said to be one drachma for a visit, or in our money seven pence three farthings. Perhaps this was the fee of a slave physician, when not prescribing for his master.

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* In order to convince Musa (says Dio Cassius) that he had arrogated to himself what was the work of fortune and fate. It was thought by some that Marcellus was poisoned.

"A fact stated by Pliny, incidentally, assigns the reason that slave physicians were so common; he says, 'that although in other professions a strict inquiry was instituted with regard to competency, there was none in the case of physicians:' hence any one, no matter how ignorant, might practise as such. But those who intended to qualify themselves regularly for the profession of medicine, became, according to the custom of the times, the pupils of experienced teachers. Thus, Themisson was pupil of Asclepiades; Serapion of Alexandria studied under Herophilus, pupil of Praxagoras; Erasistratus was pupil of Chrysippus; Prodicus, of Hippocrates; and Hippocrates, of Democritus. The prince of physicians derived part of his knowledge from the tablets in the temple of Esculapius at Cos, on which were recorded all remarkable cures. The temple was, in some time after, burned, along with its records; but the latter were preserved in the memory of Hippocrates, so far, at least, as related to dietetic medicine; for Strabo mentions, that cures effected by that kind of practice were those he selected. Many of the regular physicians studied in the celebrated university of Alexandria, founded 320 years before the Christian era, where students could avail themselves of the best instruction which the world then afforded. There were in its library, at one time, no less than 700,000 volumes, the unfortunate fate of which is well known. Up to this time, no dissections of the human body had taken place; the horror with which the Egyptians and other nations viewed the desecration of the dead had hitherto deprived medicine of the light of anatomy. But Ptolemy not only instituted human dissections, but, horrible to relate, ordered dissections of living criminals. Tertullian charges Herophilus with having been the perpetrator; Celsus admits the fact, and defends it, on the principle that the tortures of a few guilty persons were allowable for the benefit of the whole innocent race of mankind. Perhaps it was on the same principle that Louis II., of France, permitted the surgeons of Paris to perform the terrible operation of lithotomy on condemned soldiers, in order that the operators might acquire dexterity with the knife.* Such was the character of the medical school of Alexandria, that to have studied there was, in the time of the Emperor Valens, deemed a sufficient warrant for commencing practice.

"Considering all these facts, the conclusion might be drawn, that the regular physicians of antiquity were very different persons, in opportunities and acquirements, from the slave physicians. It is singular that in the language of the Greeks and Romans no verbal distinction was made in the names expressive of the two grades; and it is probably this defect that occasioned the misconception of modern writers with regard to the supposed degraded state of the whole class of ancient physicians.

"The class of regularly educated practitioners were men of learning and elegant accomplishments. To their ordinary professional acquirements in philosophy, medicine, surgery, materia medica, and pharmacy, they frequently superadded rhetoric, oratory, and poetry. Many poetical disquisitions are extant, of great merit as poems, although occasionally on very undignified subjects. Zeno of Athens wrote a poem on a gout-medicine; Marcellus composed one on medicine in

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* Mangeti Bibl. Script. Med. 1731.

[illegible] Damocrates favoured the world with a poetical effusion on the humble subject of a kind of [illegible]; he gave all his prescriptions in iambics. Andromachus, physician to Nero, dedicated to his royal master a poem descriptive of the celebrated confection which went under his name, although really invented by King Mithridates. The practice was not confined to the Romans; the Indian philosopher, [illegible], whose era is unknown, wrote a poem on pharmacy in three hundred stanzas of Tamul verse, the poetry of which, Ainslie says, is much esteemed. Such poems were not uncommon amongst Oriental writers.

“The regularly educated physicians of antiquity, far from being slaves, were the friends and associates of persons of the most exalted rank in all civilized countries. Avicenna was physician and grand vizier to the Sultan Magdal Doulet, and the companion of princes and nobles. Mesue was the fourth in descent from Abdela, king of Damascus. Menecrates of Syracuse was physician and friend of Philip of Macedon. Democedes of Crotona, the founder of the reputation of the family of Crotona, was the medical adviser and constant guest at the table of Darius the great.

“Crowned heads did not think the study of medicine beneath them. King Solomon was well versed in medical botany; his ‘History of Plants’ is said to have been burned in the library of Alexandria. King Antiochus invented an antidote to all sorts of poison, the composition of which was engraved on a stone at the entrance to the temple of Esculapius. Attalus, the last king of Pergamus, invented several useful formulæ, which have descended to us. Mithridates, king of Pontus, as already stated, invented the celebrated confection. Juba, the second king of Mauritania, wrote a book on the virtues of herbs; so also did Evax, a king of Arabia, which he dedicated to Nero. Nero himself dabbled a little in medicine. The imperial reprobate, during his nocturnal wanderings through the streets of Rome, used to get involved in pugilistic contests, and would then return home with one or two black eyes, and a face of all colours. He compounded for himself an ointment consisting of deadly carrot, frankincense, and wax, with which he smeared his face, and next morning was free from all evidence of the fistic dexterity of his subjects. Agrippa, king of the Jews, invented an ointment for debility of the nerves, which incumbered the pharmacopœias of Europe until a few centuries ago. The emperor Adrian possessed considerable knowledge of medicines and pharmacy; he invented an antidote against all sorts of poisons. The emperor Justin dictated a formula which continued in use for a thousand years.

"The prophet Esdras, while in exile at Babylon, composed a medicine which consisted of no less than one hundred and fifty ingredients, and one of these contained forty others. It would have shortened the prescription had he ordered a little of all the known medicines in the world to be mixed. This compound was in medical use until a few centuries since. St. Paul was also the inventor of a formula which has been preserved by Nicolaus Præpositus.

"Until the days of Hippocrates medicine was studied as a branch of philosophy. According to Ælian, the Pythagoreans not only studied medicine but practised it; so also, says the same authority, did Plato and Aristotle. Pythagoras gave a tolerably good formula for certain stomach complaints. Democritus, returning from his travels, wrote a book, in which he gave a prescription to enable parents to have handsome, virtuous, and fortunate children: miserably for the votaries of beauty and worth, the prescription is lost. Chrysippus and Dienchus each wrote a book on the virtues of wild cabbage. Hippocrates dissevered the connexion between philosophy and medicine, and from his time the latter began to be studied as a separate art. 'Ubi desinit physicus incipit medicus,' says Aristotle. Eminent persons still, however, cultivated medicine as a branch of a liberal education. It was in this way that Virgil studied the art.

"From the facts and considerations adduced, it appears that several centuries before the Christian era, and for some time after it, an inferior kind of medicine was practised as a servile or domestic art; in the same way as cookery, with which Plato continually compares it (Gorgias). It appears also that the higher departments were originally those of the philosophers, from whom it passed into the hands of an equally learned and respectable class, who thenceforward professed medicine only. The arrangement was natural and convenient. To possess a domestic, always accessible in case of emergency, who understood at least the incipient treatment of disease, was undoubtedly a source of satisfaction and security in a family, so much so that one is led to suspect the existence of this state of things long before and after they are alluded to in historical records. Traces of this usage are recognisable in comparatively late times; history informs us that in the courts of the ancient princes of Wales there was always a physician of so humble a grade that even the mead-maker took precedence of him.* This personage looks very like the old slave-physician.

"But it is to be inquired how these slaves acquired whatever medical knowledge they possessed. In ancient times, medicine, surgery, and pharmacy, were professed by the same individual; but the variety of processes indispensable in pharmacy rendered the employment of menials always necessary. Throughout the writings of the ancient physicians, allusion is frequently made, sometimes by name, to these operators, who were always slaves. If we had no positive authority for supposing it, probability would lead to the belief that they were the slave physicians, or their instructors.

"But we have positive information on the subject in one of the dialogues of Plato, which elucidates the whole system of the practice of medicine by regular physicians and by slaves; and it is singular that those who defended the medical art should have overlooked a passage which would have at once decided the point at issue. The dialogue is supposed to be between an Athenian and a Cretan. I extract as much of it as is sufficient for my purpose:

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* Henry's England, vol. ii. p. 362.

"'ATHENIAN.—We say that some are physicians, and others the servants (ὑπηρέται) of physicians; and these last we likewise call, in a certain respect, physicians. Do we not?

"'CRETAN.—Entirely so.

"'ATHENIAN.—And do we not call them so, whether they are free or servants, who, through the orders of their masters, have acquired the art of medicine, both according to theory and experience, but are not naturally physicians like those who are free, who have both learned the art from themselves, and instructed their children in it; or do you consider them as forming two kinds of physicians?

"'CRETAN.—Why should I not?

"'ATHENIAN.—Do you therefore understand that when, in a city, both servants and those who are free are sick, servants are for the most part cured by servants (δούλοις), who visit the multitude of the sick, and are diligently employed in the dispensaries (ἰατρείοις), and this without assigning or receiving any reason respecting the several diseases of servants; but what they have found by experience to be efficacious, they tyrannically prescribe for their patients, as if they possessed accurate knowledge, and this in an arrogant manner, hurrying from one diseased servant to another, by this means facilitating their master's attention to the sick. But the free-born physician, for the most part, heals and considers the diseases of those that are freeborn.'*

"Such was the state of things three centuries and a half before the Christian era. This dialogue establishes the fact, if there were no other proof, that there were two kinds of medical practitioners in ancient Greece, regular physicians and slave physicians, clearly distinguished by the terms *ιατρος* and *δουλος* in Plato's dialogue, although comprised under the word physician. The slaves derived their knowledge by acting in the dispensaries or shops of their masters; the slaves attended on slaves, the physicians on the free-born; the former practised empirically; the latter investigated symptoms and causes. That the same usage obtained in Rome appears from the authorities already adduced, and by the well-known tendency of the Romans to adopt Greek customs.

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* Taylor's Translation.

"The condition of medicine, and its practice in Greece and Rome, have been always involved in doubt and obscurity by the conflicting statements of ancient historians, which Le Clerc and Danet do not appear to have succeeded in reconciling. Pliny says that for more than 600 years from the foundation of the city, that is, until the year 218 B. C., there were no physicians in Rome, a sufficiently improbable assertion. On the other hand, Dionysius of Halicarnassus says, that during a dreadful pestilence which raged in Rome U. C. 301, there were not physicians enough to attend the sick, which proves there must have been physicians there. The history of Dionysius was written about a century before that of Pliny, and was therefore well known to the latter. Had Pliny understood that the persons alluded to by Dionysius were intended to be represented as regular physicians, he certainly would have made some observation on a statement so completely at variance with his own. It appears that the cause of the apparent confliction between the two historians is, that when Pliny said there were no physicians at Rome for 600 years, he meant regular physicians; and when Dionysius mentioned the inadequate number of physicians during the pestilence, he meant slave-physicians, which Pliny well understood, and therefore made no comment.

"By admitting the view of the subject here advocated, we reconcile another historical confliction which has been ineffectually attempted to be explained. The Athenians had a law which declared that 'no slave or female should learn the art of medicine.' But abundant proof has been adduced that slave-physicians were not uncommon in Greece. The law did not prohibit slaves from being the assistants of physicians, and therefore could not prevent their casually acquiring whatever medical knowledge might fall in their way. As reported by Hyginus, the edict enjoined that 'ne quis servus disceret artem medicam;' the meaning probably being that the slave should not undergo the regular course of study and discipline of the art, and thus put himself on a footing of equality with the rank of the regularly qualified physician. An edict professing to restrain a slave from learning, that is, hearing and remembering what he heard, would be as impossible in its administration as absurd in its conception.

"On the whole, I conceive that all historic records concur in showing that the real profession of medicine was never one of slavery; and that it has never been otherwise than honourable and elevated, being studied by poets, philosophers, holy persons, monarchs, and men of learning.

"Perhaps Apuleius places the slave-physician in his true position, when he says, 'Themisson noster servus' (not the pupil of Asclepiades) 'medicinæ *non ignarus*,' qu. dic. not altogether ignorant of medicine."

MAY 13TH, 1850.

The REV. HUMPHREY LLOYD, D. D., PRESIDENT, in the Chair.

HUGH CARLISLE, ESQ., M. D., was elected a member of the Academy.

A letter was read from Charles Leslie, Esq., Castle Leslie, county Monaghan, accompanying a wooden implement which had been discovered in a bog by some men cutting turf, and which Mr. Leslie presented to the Academy.

Sir William Betham read a notice from a Manuscript in the British Museum, in the handwriting of Sir James Ware, in which it was stated that Dr. John Leslie, Bishop of Raphoe, when building an episcopal palace there, pulled down a round tower or pyramid, which stood at Raphoe, and discovered the bones of a man beneath it. Sir William observed, that the letter demonstrated the existence of a round tower formerly at Raphoe. He had not been aware of that fact before, and probably many more round towers formerly existed in the country than were generally supposed.

Rev. Dr. Todd exhibited a curious piece of sculpture in white marble, being a representation of the crucifixion. He had purchased it from a man who informed him that it had for many years been in the possession of a family named Meehan, in the county of Kildare, and that it had been found in a churchyard in the town of Kildare. It evidently was of very considerable antiquity, probably of the thirteenth century.

Dr. Todd also exhibited a similar sculpture, purchased some time back by Mr. Clibborn, the design of which resembled a section of the first piece of sculpture.

The President read a letter by Dr. Osborne on a new application of thermometrical observations for the determination of local climates, in reference to the health of invalids.

"*Dublin*, 26, *Harcourt-street*, *March* 30, 1850.

"Dear Sir,—May I beg that you will excuse the liberty I take in laying before you the following observations, in order that they may be submitted to the consideration of the Committee of Science of the Royal Irish Academy, preparatory to the arrangements now in progress for an extensive series of meteorological observations throughout Ireland?

"In seeking information respecting climates suitable for invalids, I had always been disappointed; the most complete meteorological tables, comprising connected series of observations on the barometer, thermometer, rain-gauge, the clouds, and the winds, being quite inadequate to give a correct representation of the action of climate on the human constitution, or even on the feelings of the human body. I found some places proverbially cold, yet exhibiting the same thermometric heat as those which were hot, and *vice versâ;* and at last I came to consider the tables, however interesting they might be in physical geography, yet as almost useless to the physician or the invalid.

"To judge of the effects of heat or cold on the living inhabitants of a country, it must be recollected that they are all endowed with a certain temperature distinct from that of the surrounding air. We are bodies heated to nearly forty degrees above the average climate in this country, and consequently subjected to a continual refrigerating process. That this refrigeration does not depend on temperature alone, as is so generally assumed in medical works on climate, but rather on the combined effect of it taken in conjunction with moisture, with currents of air, with radiation, and with variations of the densities of air, must be manifest even from a theoretical consideration of the subject; but up to the present time this combined effect does not appear ever to have been experimentally investigated. It occurred to me that, by substituting for the human body a thermometer heated to its temperature, the time in which it cooled down in any locality would afford a measure of the cooling power of all those agencies combined in that locality. Accordingly, having heated the bulb of a thermometer to 90°, that being the average heat of the surface of the body, I observed the time it required in different situations to cool down to 80°, when taken inversely, corresponded so well with what my feelings told me of the cold of those situations, that I made a variety of experiments which convinced me of its truthfulness and value.

"Having introduced a short account of it into a paper which I read at the medical section of the British Association, when in Dublin in 1835, I proposed, in order to avoid circumlocutions, that the thermometer so applied should be called a PSYCHOMETER, or measurer of refrigeration (from ψῦχος). The members present at the meeting of the section appeared to view the proposal with great interest. No objection was offered to it, and a resolution was passed appointing committees in London, Dublin, and Edinburgh (to which copies of my communication were to be furnished), with a request that they should report to the meeting to be held in the following year.

"I have to plead guilty of a great omission and of apparent disrespect towards the Association, in not availing myself of the extensive opportunity thus promptly thrown open; but, not wishing to compromise my prospects as a practising physician, by appearing before the public in the light of an experimentalist in meteórology, I took no further steps in the matter, and never furnished the copies required. Consequently, the committees were never convened, and thus the subject was dropped, and has ever since remained totally neglected, if not totally forgotten.

"Now, however, that a series of observations on the climate of Ireland is about to be undertaken, under the auspices of the Academy, I feel that I should fail in my duty to the body of which I have the honour to be a member if I did not solicit the attention of the Committee to this mode of investigation, the practical value and probable importance of which, instead of diminishing, has steadily increased in my eyes ever since I first proposed it.

"The psychometer which I use is a spirit thermometer, with a cylindrical bulb about one and a half inch long and a third of an inch thick, the stem of which is marked to denote 80° and 90°. It is readily heated for use, either with the palm of the hand, or by holding it for a few moments inside the shirt collar. It is then to be held in the locality appointed for examination, and by means of a seconds watch the number of seconds is counted during which it falls from 90° to 80°. It is assumed that the refrigeration is inversely as the time required.

"The first example I shall give of its application is furnished by my present residence, No. 26, Harcourt-street. It nearly fronts the east, where the opposite houses are rather higher, but is in the rear much exposed to the west. Now, the rooms in the rear have almost always been felt to be colder than those in the front; but the reason of this was never to be appreciated by the thermometer, as, when in the shade, it maintains nearly the same degree in both aspects. Several observations were made, in order to ascertain the difference of refrigeration between the front and back of the house, in the morning after sunrise, but in the shade, and the same number made after sunset, during the end of the last and beginning of the present month. They were made by holding the instrument outside the attic windows, front and rear.

"From these it appeared that the refrigeration of both aspects was equal in only one instance; that it was greatest at the east, in three instances; but that, on the average, the cold of the west aspect was to that of the east nearly as 5 to 4, and that this difference appeared to increase after sunset.

"Another series of observations made for me at Monkstown, and confined to the one spot, shows how great a discrepancy may be between the indications of the thermometer and the cold produced by the air on a body heated up to our temperature. Thus, on the 8th of January, the temperature being 41°, the instrument required 40″ for cooling; and on the 9th, the temperature being the same, it cooled in 17½″, that is, in less than half the time: showing a refrigeration of twice the power. This may be explained by the *damp strong breeze* in the latter case, and the *almost calm clear atmosphere* in the other; but those are the states of the atmosphere in which we are most interested, and on the effects of which much of our health and comfort must always depend.

"It will be observed how we often suffer more severely from cold when the temperature is a little above than when below the freezing point, in consequence of the presence of moisture in the former case causing increase of conducting power. To this may be ascribed the greater cold so often felt in this climate than in continental localities, even when the temperature is many degrees below freezing point.

"If the Committee shall be of opinion that the refrigerating effects of climate in various parts of Ireland shall be investigated in the manner I have ventured to propose, I cannot refrain from anticipating much useful and much hitherto unexpected information to result; and, taken in connexion with their other meteorological researches, I should hope that in this country, now so much thrown on her own natural resources, it may help to teach us the real influences of aspects and prevailing winds, and lead us to a scientific application of them to practical purposes. Again begging your indulgence,

"I have the honour to remain,
"Dear Mr. President,
"Your most obedient Servant,
"JONATHAN OSBORNE, M. D.,
"*King's Prof. Mat. Med.*

"*Rev. Dr. Lloyd.*"

The President observed, in reference to the preceding communication, that the cooling power of the air—as measured by the time in which a thermometer, artificially heated, cooled down through half the excess of its temperature above that of the surrounding air—had been already used by Leslie to measure the *velocity of the wind*, the effects of other causes being eliminated by means of a second observation in *still* air. This employment of a heated thermometer as an *anemometer*, although apparently not so well known as it deserved, seemed to be the most valuable application of which it was capable, considered as an instrument of *physical* investigation. The object of Dr. Osborne's inquiries was, however, rather medical than physical, and there could be no doubt that the means which he proposed were (with some modifications) adequate to the object in view.

Dr. Apjohn suggested some additions and alterations in the method of observation proposed by Dr. Osborne.

Sir William Rowan Hamilton gave an account of some geometrical reasonings, tending to explain and confirm certain results to which he had been previously conducted by the method of quaternions, respecting the inscription of gauche polygons in central surfaces of the second order.

1. It is a very well known property of the conic sections, that if three of the four sides of a plane quadrilateral inscribed in a given plane conic be cut by a rectilinear transversal in three given points, the fourth side of the same variable quadrilateral is cut by the same fixed right line in a fourth point likewise fixed. And whether we refer to the relation of involution discovered by Desargues, or employ other principles, it is easy to extend this property to *surfaces* of the second order, so far as the inscription in them of *plane* quadrilaterals is concerned. If then we merely wish to pass from one point P to another point R of such a surface, under the condition that some other point Q of the same surface shall exist, such that the two successive and rectilinear chords, PQ and QR, shall pass respectively through some two given *guide-points*, A and B, internal or external to the surface; we are allowed to *substitute*, for this pair of guide-points, *another pair*, such as B′ and A′, situated *on the same straight line* AB; and may choose *one* of these two new points *anywhere* upon that line, provided that the *other* be then suitably chosen. In fact, if C and C′ be the two (real or imaginary) points in which the surface is crossed by the given transversal AB, we have only to take care that the three pairs of points AA′, BB′, CC′, shall be in involution. And it is important to observe, that in order to determine one of the new guide-points, B′ or A′, when the other is given, it is by no means necessary to employ the points C, C′, of intersection of the transversal with the surface, which may be as often imaginary as real. We have only to *assume* at pleasure a point P upon the given surface; to draw from it the chords PAQ, QBR; and then if A′ be given, and B′ sought, to draw the two new chords RA′S, SB′P; or else if A′ is to be found from B′, to draw the chords PB′S, SA′R. For example, if we choose to throw off the new guide-point B′ to infinity, or to make it a *guide-star*, in the direction of the given line AB, we have only to draw, from the assumed initial and superficial point P, a rectilinear chord PS of the surface, which

shall be parallel to AB, and then to join SR, and examine in what point A′ this joining line crosses the given line AB. The point A′ *thus* found will be entirely independent of the assumed initial point P, and will satisfy the condition required: in such a manner that if, from any *other* assumed superficial point P′, we draw the chords P′AQ′, Q′BR′, and the parallel P′S′ to AB, the chord R′S′ shall pass through the *same* point A′. All this follows easily from principles perfectly well known.

2. Since then for *two* given guide-points we may thus substitute the system of a guide-star and a guide-point, it follows that for *three* given guide-points we may substitute a guide-star and two guide-points; and, therefore, by a repetition of the same process, may substitute anew a system of two stars and one point. And so proceeding, for a system of n given guide-points, through which n successive and rectilinear chords of the surface are to pass, we may substitute a system of $n-1$ guide-stars, and of a single guide-point. The problem of inscribing, in a given surface of the second order, a gauche polygon of n sides, which are required to pass successively through n given points, is, therefore, in general, reducible, by operations with straight lines alone, to the problem of inscribing in the same surface another gauche polygon, of which the *last* side shall pass through a new fixed point, while all its *other* $(n-1)$ sides shall be parallel to so many fixed straight lines. And if the *first* n sides of an inscribed polygon of $n+1$ sides, $PP_1P_2 \ldots P_n$, be obliged to pass, in order, through n given points, $A_1 A_2 \ldots A_n$, namely, the side or chord PP_1 through A_1, &c., it will then be possible, in general, to incribe also *another* polygon, $PQ_1 Q_2 \ldots P_n$, having the same first and nth points, P and P_n, and therefore the *same final* or closing side P_nP, but having the other n sides *different*, and such that the $n-1$ first of these sides, PQ_1, $Q_1 Q_2$, $\ldots Q_{n-2} Q_{n-1}$, shall be respectively parallel to $n-1$ given right lines, while the nth side $Q_{n-1} P_n$ shall pass through a fixed point B_n.

The analogous reductions for polygons in conic sections have long been familiar to geometers.

3. Let us now consider the inscribed gauche quadrilateral $PQ_1Q_2Q_3$, of which the four corners coincide with the four first points of the last-mentioned polygon. In the plane $Q_1Q_2Q_3$ of the second and third sides of this gauche quadrilateral, draw a new chord Q_1R_2, which shall have its direction conjugate to the direction of PQ_1, with respect to the given surface. This new direction will itself be fixed, as being parallel to a fixed plane, and conjugate to a fixed direction, not generally conjugate to that plane; and hence in the plane inscribed quadrilateral $R_2Q_1Q_2Q_3$, the three first sides having fixed directions, the fourth side Q_3R_2 will also have its direction fixed: which may be proved, either as a limiting form of the theorem referred to in (1), respecting four points in one line, or from principles still more elementary. And there is no difficulty in seeing that because PQ_1 and Q_1R_2 have fixed and conjugate directions, the chord PR_2 is bisected by a fixed diameter of the surface, whose direction is conjugate to both of their's; or in other words, that if O be the centre of the surface, and if we draw the *variable* diameter PON, the variable *chord* NR_2 will then be parallel to the *fixed* diameter just mentioned. So far, then, as we only concern ourselves to construct the fourth or closing side Q_3P of the gauche quadrilateral $PQ_1Q_2Q_3$, whose three first sides have given or fixed directions, we may substitute for it another gauche quadrilateral PNR_2Q_3, inscribed in the same surface, and such that while its first side PN passes through the centre O, its second and third sides, NR_2 and R_2Q_3, are parallel to two fixed right lines. In other words, we may substitute, for a system of *three guide-stars*, a system of the *centre and two stars*, as guides for the three first sides; or, if we choose, instead of drawing successively three chords, PQ_1, Q_1Q_2, Q_2Q_3, parallel to three given lines, we may draw a first chord PR_2, so as to be bisected by a given diameter, and then a second chord R_2Q_3, parallel to a given right line.

4. Since, for a system of *three* stars, we may substitute a system of the centre and *two* stars, it follows that for a system of *four* stars we may substitute a system of the centre and *three* stars; or, by a repetition of the same process, may substitute a system of the centre, the same centre *again*, and two stars; that is, ultimately, a system of *two* stars may be substituted for a system of *four* stars, the two employments of the centre as a guide having simply neutralized each other, as amounting merely to a *return* from N to P, after having *gone* from P to the diametrically opposite point N. For five stars we may therefore substitute three; and for six stars we may substitute four, or two. And so proceeding we perceive that, for *any* proposed system of guide-stars, we may substitute *two* stars, if the proposed number be even; or *three*, if that number be odd. And by combining this result with what was found in (2), we see that for any given system of n guide-points we may substitute a system of *two stars and a point*, if n be *odd*; or if n be *even*, then in that case we may substitute a system of *three* stars and a point: which may again be changed, by (3), to a system of the *centre*, *two stars, and one point*.

5. Let us now consider more closely the system of two guide-stars, and one guide-point; and for this purpose let us conceive that the two first sides PQ_1 and Q_1Q_2 of an inscribed gauche quadrilateral $PQ_1Q_2P_3$ are parallel to two given right lines, while the third side Q_2P_3 is obliged to pass through a fixed point B_3; the first point P, and therefore also the quadrilateral itself, being in other respects variable. In the plane PQ_1Q_2 of the two first sides, which is evidently parallel to a fixed plane, inscribe a chord Q_2S, whose direction shall be conjugate to that of the fixed line OB_3, and therefore shall itself also be fixed, O being still the centre of the surface; and draw the chord PS. Then, in the plane inscribed quadrilateral PQ_1Q_2S, the three first sides have fixed directions, and therefore, by (3), the direction of the fourth side SP is also fixed. In the plane SQ_2P_3, which contains the given point B_3, draw

through that point an indefinite right line B_3C_3, parallel to SP_2: this line so drawn will have a given position, and will be intersected, at some finite or infinite distance from B_3, by the chord SP_3, which is situated in the same plane with it, namely, in the plane SP_2B_3. For if we consider the section of the surface which is made by this last plane, and observe that the two first sides of the triangle SP_2P_3 pass, by the construction, through a star or point at infinity conjugate to B_3, and through the point B_3 itself, we shall see that, in virtue of a well-known and elementary principle respecting triangles in conics, the third side P_3S must pass through the point D_3, if D_3 be the pole of the right line B_3C_3, which contains upon it the two conjugate points: this pole being taken with respect to the plane section lately mentioned. If then we denote by D_3E_3 the indefinite right line which is, with respect to the *surface*, the *polar* of the fixed line B_3C_3, we see that the chord SP_3 must intersect this reciprocal polar also, besides intersecting the line B_3C_3 itself. Conversely this condition, of intersecting these two fixed polars, is sufficient to enable us to draw the chord SP_3, when the point S has been determined, by drawing from the assumed point P the chord PS parallel to a fixed right line. We may then *substitute*, for a system of two guide-stars and one guide-point, the system of *one guide-star* and *two guide-lines*; these lines being (as has been seen) a pair of *reciprocal polars*, with respect to the given surface.

6. If, then, it be required to inscribe a polygon $PP_1P_2 \ldots P_{2n}$ with any odd number $2n + 1$ of sides, which shall pass successively through the same number of given points, $A_1A_2 \ldots A_{2n+1}$, we may begin by *assuming* a point P upon the given surface, and drawing through the given points $2n + 1$ successive chords, which will in general conduct to a final point P_{2n+1}, *distinct* from the assumed initial point P. And then, by processes of which the nature has been already explained, we can find a point S such that the chord PS shall be parallel to a fixed right line, or shall have a direction independent of the assumed

and variable position of P; and that the chord SP_{2n+1} shall at the same time cross two other fixed right lines, which are reciprocal polars of each other. In order then to find a *new* point P, which shall satisfy the conditions of the proposed problem, or shall be such as to *coincide* with the point P_{2n+1}, deduced from it as above, we see that it is necessary and sufficient to oblige this sought point P to be situated at one or other extremity of a certain chord PS, which shall at once be parallel to a fixed line, and shall also cross two fixed polars. It is clear then that we need only draw two planes, containing respectively these two polars, and parallel to the fixed direction; for the right line of intersection of these two planes will be the *chord of solution* required; or in other words, it will cut the surface in the two (real or imaginary) points, P and S, which are adapted, and are alone adapted, to be positions of the first corner of the polygon to be inscribed.

7. But if it be demanded to inscribe in the same surface a polygon $PP_1P_2 \ldots P_{2n-1}$, with an *even* number $2n$ of sides, passing successively through the same *even* number of given points, $A_1A_2 \ldots A_{2n}$, *the problem then acquires a character totally distinct.* For if, after assuming an initial point P upon the surface, we pass, by $2n$ successive chords, drawn through the given points A_1, &c., to a final point P_{2n} upon the surface, which will thus be in general distinct from P; it will indeed be possible to assign generally two fixed polars, across which, as two given guide-lines, a certain variable chord SP_{2n} is to be drawn, like the chord SP_{2n+1} of (6); but the chord PS will *not*, in *this* question, be *parallel to a given line*, or directed to a given star; it will, on the contrary, by (3) (4) (5), be *bisected by a given diameter*, which we may call AB; or, if we prefer to state the result so, it will be now the *supplementary chord* NS of the same diametral section of the surface (N being still the point of that surface *opposite* to P), which will have a given direction, and *not* the chord PS itself. In fact, at the end of (4), we reduced the system of $2n$ guide-points to a system of

the centre, two stars, and one point; and in (5) we reduced the system of two stars and a point to the system of a star and two polars. In order then to find a point P which shall *coincide* with the point P_{2n} deduced from it as above, or which shall be adapted to be the first corner of an inscribed polygon of $2n$ sides passing respectively through the $2n$ given points, $A_1 \,..\, A_{2n}$, we must endeavour to find a chord PS which shall be at once bisected by the fixed diameter AB, and shall *also* intersect the two fixed polars above mentioned. And conversely, if we can find any such chord PS, it will necessarily be at least *one chord of solution* of the problem; understanding hereby, that if we set out with *either* extremity, P or S, of this chord, and draw from it $2n$ successive chords PP_1, &c., or SS_1, &c., through the $2n$ given points A_1, &c., we shall be brought *back* hereby (as the question requires) to the point with which we started. For, in a process which we have proved to admit of being *substituted* for the process of drawing the $2n$ chords, we shall be brought first from P to S, and then back from S to P; or else first from S to P, and then back from P to S: provided that the chord of solution PS has been selected so as to satisfy the conditions above assigned.

8. *To inscribe then*, for example, *a gauche chiliagon in an ellipsoid*, $PP_1 \,..\, P_{999}$, or $SS_1 \,..\, S_{999}$, under the condition that *its thousand successive sides shall pass successively through a thousand given points* $A_1 \,..\, A_{1000}$, we are conducted to seek to inscribe, in the same given ellipsoid, a *chord* PS, which shall be at once *bisected by a given diameter* AB, and also *crossed by a given chord* CD, *and by the polar of that given chord.* Now in general when any two proposed right lines intersect each other, their respective polars also intersect, namely, in the pole of the plane of the two lines proposed. Since then the sought chord PS intersects the polar of the given chord CD, it follows that the polar of the same sought chord PS must intersect the given chord CD itself. We may therefore reduce the problem to this form: to find a chord PS of the ellipsoid

which shall be bisected by a given diameter AB, and shall also be such that while it intersects a given chord CD in some point E, its polar intersects the prolongation of that given chord, in some other point F.

9. The two sought points E, F, as being situated upon two polars, are of course *conjugate* relatively to the *surface;* they are therefore also conjugate relatively to the *chord* CD, or, in other words, they cut that given chord *harmonically.* The four diametral planes ABC, ABE, ABD, ABF, compose therefore an harmonic pencil; the second being, *in this pencil,* harmonically conjugate to the fourth; and being at the same time, on account of the polars, conjugate to it also with respect to the *surface,* as one diametral plane to another. When the ellipsoid becomes a *sphere,* the conjugate planes ABE, ABF become *rectangular;* and consequently the sought plane ABE *bisects the angle* between the two given planes ABC and ABD. *This solves at once the problem for the sphere;* for if, conversely, we thus bisect the given dihedral angle CABD by a plane ABE, cutting the chord CD in E, and if we take the harmonic conjugate F on the same given chord prolonged, and draw from E and F lines meeting ordinately the given diameter AB, these two right lines will be situated in two rectangular or conjugate diametral planes, and will satisfy all the other conditions requisite for their being polars of each other; but each intersects the given chord CD, or that chord prolonged, and therefore each intersects also, by (8), the polar of that chord; each therefore satisfies all the transformed conditions of the problem, and gives a chord of solution, real or imaginary. More fully, the ordinate EE′ to the diameter AB, drawn from the *internal* point of harmonic section E of the chord CD, gives, when prolonged both ways to meet the surface, the *chord of real solution,* PS; and the other ordinate FF′ to the same diameter AB, which is drawn from the *external* point of section F of the same chord CD, and which is itself wholly external to the surface, is the *chord of imaginary solution.* But

because when we return from the sphere to the *ellipsoid*, or other surface of the second order, the condition of *bisection* of the given dihedral angle CABD is no longer fulfilled by the sought plane ABE, a slight generalization of the foregoing process becomes necessary, and can easily be accomplished as follows.

10. Conceive, as before, that on the diameter AB the ordinate EE′ is let fall from the internal point of section E, and likewise the ordinates CC′ and DD′ from C and D; and draw also, parallel to that diameter, the right lines CC″, DD″, EE″, from the same three points C, D, E, so as to terminate on the diametral plane through O which is conjugate to the same diameter; in such a manner that OC″, OD″, OE″ shall be parallel and equal to the ordinates C′C, D′D, E′E; and that the segments CE, ED of the chord CD shall be proportional to the segments C″E″, E″D″ of the base C″D″ of the triangle C″OD″, which is situated in the diametral plane, and has the centre O for its vertex. For the case of the *sphere*, the vertical angle C″OD″ of this triangle is, by (9), bisected by the line OE″; wherefore the sides OC″, OD″, or their equals, the ordinates C′C, D′D, are, in this case, proportional to the segments C″E″, E″D″ of the base, or to the segments CE, ED of the chord: while the squares of the ordinates are, for the same case of the sphere, equal to the rectangles AC′B, AD′B, under the segments of the diameter AB. Hence, *for the sphere, the squares of the segments of the given chord are proportional to the rectangles under the segments of the given diameter*, these latter segments being found by letting fall ordinates from the ends of the chord; or, in symbols, we have the proportion,

$$CF^2 : DF^2 :: CE^2 : ED^2 :: AC'B : AD'B.$$

But, by the general principles of *geometrical deformation, the property, thus stated, cannot be peculiar to the sphere. It must extend*, without any further modification, *to the ellipsoid;* and it gives at once, for that surface, the two points of harmonic section, E and F, of the given chord CD, through which points the two sought *chords of real and imaginary solution* are to pass; *these chords of solution are therefore completely determined*, since they are to be also ordinates, as before, to the given diameter AB. *The problem of inscription for the ellipsoid is therefore fully resolved; not only* when, as in (6), the number of sides of the polygon is *odd*, but *also* in the more difficult case (7), when the number of sides is *even*.

11. If the given surface be a hyperboloid of *two sheets*, *one* of the two fixed polars will still intersect that surface, and the fixed chord CD may still be considered as *real*. If the given diameter AB be also real, the proportion in (10) still holds good, without any modification from imaginaries, and determines still a real point E, with its harmonic conjugate F, through one or other of which two points still passes a *chord of real solution*, while through the other point of section still is drawn a *chord of imaginary solution*, reciprocally polar to the former. But if the *diameter* AB be *imaginary*, or in other words if it fail to meet the proposed hyberboloid at all, we are then led to consider, instead of it, an *ideal diameter* A'B', having the same *real direction*, but terminating, in a well-known way, on a certain *supplementary surface*; in such a manner that while A and B are now *imaginary points*, the points A' and B' are *real*, although *not really situated on the given surface*; and that

$$OA^2 = OB^2 = -OA'^2 = -OB'^2.$$

The points C' and D' are still real, and so are the rectangles AC'B and AD'B, although A and B are imaginary; for we may write,

$$AC'B = OA^2 - OC'^2,\ AD'B = OA^2 - OD'^2,$$

and the proportion in (10) becomes now,

$$CF^2 : DF^2 :: CE^2 : ED^2 :: OC'^2 + OA'^2 : OD'^2 + OA'^2.$$

It gives therefore still a *real point of section* E, and a *real con-*

jugate point F; and through these two points of section of CD we can still draw *two real right lines*, which shall still ordinately cross the real direction of AB, and shall still be two reciprocal polars, satisfying all the transformed conditions of the question, and coinciding still with two chords of real and imaginary solution. *For the double-sheeted hyperboloid*, therefore, *as well* as for the ellipsoid, the problem of inscribing a *gauche chiliagon*, or other *even-sided polygon*, whose sides shall pass successively, and in order, through the same given number of points, is solved by a system of *two polar chords*, which we have assigned geometrical processes to determine; and the solutions are *still*, in general, *four* in number; *two* of them being still *real*, and *two imaginary*.

12. If the given surface be a hyperboloid of *one sheet*, then not only may the diameter AB be real or imaginary, but also the chord CD may or may not cease to be real; for the two fixed polars will *now* either *both meet* the surface, or else *both fail* to meet it in any two real points. When AB and CD are both real, the proportion in (10), being put under the form

$$\mathrm{CF}^2 : \mathrm{DF}^2 :: \mathrm{CE}^2 : \mathrm{ED}^2 :: \mathrm{OA}^2 - \mathrm{OC}'^2 : \mathrm{OA}^2 - \mathrm{OD}'^2,$$

shews that the point of section E and its conjugate F will be real, if the points C′ and D′ fall *both* on the diameter AB *itself*, or *both* on that diameter *prolonged*; that is, if the extremities C and D lie *both within* or *both without* the interval between the two parallel tangent planes to the surface which are drawn at the points A and B: under these conditions therefore there will still be *two real right lines*, which may still be called the *two chords of solution*; but because these lines will still be two reciprocal polars, they will now (like the two fixed polars above mentioned) either *both meet* the hyperboloid, or else *both fail* to meet it; and consequently there will now be either *four real*, or else *four imaginary* solutions. If AB and CD be still both real, but if the chord CD have *one* extremity *within* and the *other* extremity *without* the interval between the two parallel tangent planes, the proportion above written will assign a *negative ratio* for the squares of the segments of CD; the points of section E and F, and the *two polar chords* of solution, become therefore, in *this* case, *themselves imaginary;* and of course, by still stronger reason, the four solutions of the problem become then imaginary likewise. If CD be real, but AB imaginary, the proportion in (11) conducts to two real points of section, and consequently to two real chords, which may, however, correspond, as above, either to four real or to four imaginary solutions of the problem. And, finally, it will be found that the same conclusion holds good also in the remaining case, namely, when the chord CD becomes imaginary, whether the diameter AB be real or not; that is, when the two fixed polars do not meet, in any real points, the single-sheeted hyperboloid.

13. Although the case last mentioned may still be treated by a modification of the proportion assigned in (10), which was deduced from considerations relative to the sphere, yet in order to put the subject in a clearer (or at least in another) point of view, we may now resume the problem for the ellipsoid as follows, without making any use of the spherical deformation. It was required to find two lines, reciprocally polar to each other, and ordinately crossing a given diameter AB of the ellipsoid, which should also cut a given chord CD of the same surface, internally in some point E, and externally in some other point F. Bisect CD in G, and conceive EF to be bisected in H; and besides the four old ordinates to the diameter AB, namely CC′, DD′, EE′, and FF′, let there be now supposed to be drawn, as two new ordinates to the same diameter, the lines GG′ and HH′. Then G′ will bisect C′D′, and H′ will bisect E′F′; while the centre O of the ellipsoid will still bisect AB. And because the points E′ and F′ are harmonic conjugates, not only with respect to the points A and B, but also with respect to the points C′ and D′, we shall have the following equalities:

$$\mathrm{H'F'}^2 = \mathrm{H'E'}^2 = \mathrm{H'A}\,.\,\mathrm{H'B} = \mathrm{H'C'}\,.\,\mathrm{H'D'},$$
$$= \mathrm{H'O}^2 - \mathrm{OA}^2 = \mathrm{H'G'}^2 - \mathrm{G'C'}^2.$$

Hence,

$$\mathrm{OH'}^2 - \mathrm{G'H'}^2 = \mathrm{OA}^2 - \mathrm{C'G'}^2,$$

that is,

$$\mathrm{OH'} = \frac{\mathrm{OA}^2 + \mathrm{OG'}^2 - \mathrm{C'G'}^2}{2\mathrm{OG'}} = \frac{\mathrm{OA}^2 + \mathrm{OC'}\,.\,\mathrm{OD'}}{\mathrm{OC'} + \mathrm{OD'}}\,.$$

Now each of these two last expressions for $\mathrm{OH'}$ remains real, and assigns a real and determinate position for the point $\mathrm{H'}$, even when the points $\mathrm{C'}$, $\mathrm{D'}$, or the points A, B, or when both these pairs of points at once become imaginary; for the points O and $\mathrm{G'}$ are still in all cases real, and so are the squares of OA and $\mathrm{C'G'}$, the rectangle under $\mathrm{OC'}$ and $\mathrm{OD'}$, and the sum $\mathrm{OC'} + \mathrm{OD'}$. Thus $\mathrm{H'}$ can always be found, as a real point, and hence we have a real value for the square of $\mathrm{H'E'}$, or $\mathrm{H'F'}$, which will enable us to assign the points $\mathrm{E'}$ and $\mathrm{F'}$ themselves, or else to pronounce that they are imaginary.

14. We see at the same time, from the values $\mathrm{H'O}^2 - \mathrm{OA}^2$ and $\mathrm{H'G'}^2 - \mathrm{C'G'}^2$ above assigned for $\mathrm{H'E'}^2$ or $\mathrm{H'F'}^2$, that these two sought points $\mathrm{E'}$ and $\mathrm{F'}$ must both be real, unless the two fixed points A and $\mathrm{C'}$ are themselves both real, since O, $\mathrm{G'}$, $\mathrm{H'}$, are, all three, real points. But for the ellipsoid, and for the double sheeted hyperboloid, we can in general *oblige* the points C, D, and their projections $\mathrm{C'}$, $\mathrm{D'}$, to become imaginary, by selecting *that one* of the two fixed polars which does *not* actually meet the surface; for *these* two sorts of surfaces, the two polar chords of solution of the problem of inscription of a gauche polygon with an even number of sides passing through the same number of given points, are therefore found anew to be two *real lines*, although only one of them will actually intersect the surface, and only two of the four polygons will (as before) be real. And even for the single sheeted hyperboloid, in order to render the two chords of solution *imaginary lines*, it is necessary that the two given polars should actually meet the

surface; for otherwise the polar lines deduced will still be real. It is necessary also, for the imaginariness of the two lines deduced, that the given diameter AB should be itself a real diameter, or in other words that it should actually intersect the hyperboloid. But even when the given chord CD and the given diameter AB are thus *both* real, and when the surface is a single *sheeted* hyperboloid, it does not *follow* that the two chords of solution *may not* be real lines. We shall only have *failed to prove* their reality by the expressions recently referred to. We must *resume*, for this case, the reasonings of (12), or some others equivalent to them; and we find, as in that section of this Abstract, for the imaginariness of the two sought polar lines, the condition that *one* of the two extremities of the given and real chord CD shall fall *within*, and that the *other* extremity of that chord shall fall *without* the interval between the two real and parallel tangent planes to the single sheeted hyperboloid, which are drawn at the extremities of the real diameter AB. Sir W. R. Hamilton confesses that the case where all these particular conditions are combined, so as to render *imaginary* the two polar lines of solution, had not occurred to him when he made to the Royal Irish Academy his communication of June, 1849.

15. It seems to him worth while to notice here that instead of the foregoing *metric* processes for finding (when they exist) the two lines of solution of the problem, the following *graphic* process of construction of those lines may always, at least in theory, be substituted, although in practice it will sometimes require modification for imaginaries. In the diametral plane ABC, draw a chord KD′L, which shall be bisected at the known point D′ by the given diameter AB; and join CK, CL. These joining lines will cut that diameter in the two sought points E′, F′; which being in this manner found, the two sought lines of solution EE′, FF′, are constructed without any difficulty. For the sphere, the ellipsoid, and the hyperboloid of two sheets, although not always for the single sheeted hyper-

boloid, this simple and graphic process can actually be applied, without any such modification from imaginaries as was above alluded to. The consideration of non-central surfaces does not enter into the object of the present communication; nor has it been thought necessary to consider in it any limiting or exceptional cases, such as those where certain positions or directions become indeterminate, by some *peculiar* combinations of the data, while yet they are *in general* definitely assignable, by the processes already explained.

16. Sir William Rowan Hamilton is unwilling to add to the length of this communication by any historical references; in regard to which, indeed, he does not consider himself prepared to furnish anything important, as supplementary to what seems to be pretty generally known, by those who feel an interest in such matters. He has however taken some pains to inquire, from a few geometrical friends, whether it is *likely* that he has been anticipated in his results respecting the inscription of *gauche* polygons in *surfaces* of the second order; and he has not hitherto been able to learn that any such anticipation is thought to exist. Of course he knows that he must, consciously and unconsciously, be in many ways indebted to his scientific contemporaries, for their instructions and suggestions on these and on other subjects; and also to his acquaintance, imperfect as it may be, with what has been done in earlier times. But he conceives that he only does justice to the yet infant Method of Quaternions (communicated to the Royal Irish Academy for the first time in 1843), when he states that he considers himself to owe, to that new method of geometrical research, not merely the *results* stated to the Academy in the summer of 1849, respecting these inscriptions of gauche polygons, and several other connected although hitherto unpublished results, which to him appear remarkable, but also the *suggestion* of the mode of *geometrical* investigation which has been employed in the present Abstract. No doubt the principles used in it have all been very elementary,

and perhaps their combination would have cost no serious trouble to any experienced geometer who had chosen to attack the problem. But to his *own* mind the whole foregoing investigation presents itself as being (what in fact in his case it *was*) a mere *translation of the quaternion analysis into ordinary geometrical language*, on this particular subject. And he will not complicate the present Abstract by giving, on *this* occasion, any account of those *other* theorems respecting polygons in surfaces, to which the Calculus of Quaternions has conducted him, but of which he has not yet seen how to *translate the proofs* (for it is easy to translate the *results*) into the usual language of *geometry*.

Sir William Rowan Hamilton gave also an account of some *general* researches, respecting curvatures of surfaces, and geodetic triangles thereon, conducted by the method of quaternions; but desires that the publication of the Abstract of this communication may be postponed to another occasion.

MAY 27TH, 1850.

THE REV. HUMPHREY LLOYD, D. D., PRESIDENT, in the Chair.

DR. TODD exhibited to the Academy two small quarto paper MSS. in the Irish language and character, the property of the Royal Burgundian Library at Brussels.

He stated that his attention was first called to these MSS. by the communication made to the Academy on the 24th of May, 1847, by Mr. Bindon, relative to the Irish MSS. preserved in that library. Soon afterwards Mr. Graves, the Secretary of Council, having had occasion to visit Brussels, was kind enough to send him (Dr. Todd) a very detailed account of these and one or two other MSS., which seemed to be of peculiar interest to the student of Irish history. This induced him to visit Brussels himself, and to inspect the MSS. in question. He there collated the curious history of the Danish wars in Ireland, of which there is an imperfect copy in the Library of Trinity College. He transcribed the passages deficient in that copy, and brought home a list of the various readings found in the Brussels MS. of that very important tract, with a view to its publication; but time did not permit him to do more. He saw, however, that the two volumes now exhibited to the Academy were of much greater importance, and were in fact the most valuable documents for the illustration of the ecclesiastical history and topograghy of Ireland that have been as yet discovered. He hoped, therefore, that, as he now has it in his power to exhibit them to the Academy, some account of their contents would not be unacceptable. But first it was necessary to explain how they came into his possession, and how it was that he was enabled to exhibit them here. He owes this privilege to the very great kindness of his Excellency the Lord Lieutenant of Ireland. Dr. Todd was so much impressed with the great importance of obtaining copies of the MSS. now before the Academy, that he ventured to state the case to His Excellency, having been informed at Brussels, that the Belgian Government would make no difficulty about lending the MSS., if application were made to them by the Government here. The Lord Lieutenant, although he was then in London, and occupied with much urgent public business, very kindly took the matter up, made the necessary communication to the Belgian authorities, and in short obtained the MSS., with full permission to have transcripts made of them.

Dr. Todd exhibited the beautiful copies of these valuable records which had been made for him by Mr. Eugene Curry; copies which he had no hesitation in saying were much more valuable than the originals, as being not only more legible and intelligible, but also in many respects more correct. He then proceeded to describe the contents of the two curious volumes thus recovered to Ireland; premising that they were both in the handwriting of the celebrated friar, Michael O'Clery, well known as being one of the chroniclers to whom Colgan gave the honourable appellation of "the Four Masters." The first volume was the original autograph MS. of the Martyrology of Donegal, so often referred to by Colgan in his Acta Sanctorum. It contained the original attestations, in the Irish language, of the professional antiquaries, Flan Mac Aodhagain [Egan] and Conor Mac Brody, together with the approbation (in Latin) of the Roman Catholic Prelates, Malachy, Archbishop of Tuam; Boetius, Bishop of Elphin; Thomas Fleming, Archbishop of Dublin; and Roch, Bishop of Kildare. These documents possess the autograph signatures of the parties, and are dated in November and December, 1636, and in January and February, 1637. Of Michael O'Clery, the principal author or compiler of this Martyrology, we learn from Colgan that he was by profession an antiquary, and eminently learned in the history and antiquities of Ireland. After joining the Franciscan Order at the Convent of Louvain, he was permitted by his superiors to continue his favourite studies, and was even sent into Ireland for the purpose of collecting materials for a work on the lives of the Irish saints, which was contemplated by the guardian of the convent, the learned father Hugh Ward, but which his death in 1637 unfortunately put an end to. The volumes now before the Academy were in part the results of O'Clery's researches; and having been placed in the hands of Colgan, after the death of Ward, they have been virtually the means of preserving to us almost all that is now known of the history of the saints of Ireland. Colgan's labours, however, were also interrupted by his death, after he had completed but three months of the year, and we must, therefore, still have recourse to original sources for information respecting the saints whose festivals occur in the nine remaining months. This circumstance greatly enhances the value of the volumes now recovered, and renders it a matter of great congratulation to the friends of Irish history that they have been transcribed, and their contents made accessible to Irish scholars. The Martyrology of Donegal was not altogether the work of Michael O'Clery, although he was probably the principal compiler. He was assisted, as Colgan tells us, by the other three antiquaries, who were also his colleagues in the compilation of the Annals of the Four Masters; and there were likewise others in the Convent of Donegal, who gave their aid by supplying notices of those Irish saints who had lived in foreign countries, or whose acts were recorded by foreign historians. The MS. which contains this valuable work is divided into two parts. In the first part the saints are in the order of the months of the year, at the days on which their memories were honoured in Ireland. In the second part the names of the saints are arranged alphabetically. In both parts several curious notices occur incidentally, in which ancient books, not now known to exist, are quoted, and in which ancient croziers, shrines, and reliquaries, are mentioned, most of which have entirely disappeared. A note at the end of the volume informs us that the Martyrology was begun and finished in the Convent of Donegal, and that it was completed on the 19th of April, 1630.

The second volume is even still more important, for it contains copies of some of the original documents from which the former work was compiled. These are also in the autograph of Michael O'Clery, transcribed by him from ancient MSS., which have probably long since perished. The first sixty-seven pages of the volume are occupied with some ancient poems in the Irish language, all bearing out the history of the Irish saints, with several other documents of very great interest to the student of church history. Amongst them are the Confession, or Litany of St. Kiaran, the Lorica (as it is called) of St. Columbkille, the history of the twelve apostles of Ireland, &c. This portion of the volume contains also the only copies we possess of the very curious Regulæ, or religious Rules of the principal founders of religious houses in Ireland, such as the Rule of Eachtgus O'Cuanain of the Abbey of Roscrea, the Rule of Columbkille, the Rule of St. Ailbhe of Emly, the Rule of Cormac Mac Cuillenain of Cashel, the Rule of St. Comhgall of Bangor, &c. These rules are, for the most part, in metre, and along with them are several curious poems attributed to the principal saints of Ireland, throwing very great light on the religious opinions, manners, and customs of the Irish Church, from the fifth to the twelfth century. This portion of the volume, the writer tells us, was transcribed from ancient MSS., partly in the Abbey of Quin, county Clare, in 1634, partly at Drobhaois, now Bundroose, county Sligo, in 1630. The remainder of the volume is occupied by the Feilire, or Martyrology, of St. Aenghus the Culdee, the Martyrology of Marianus Gorman, the Martyrology of Tallaght, and the Naoimhgenealach, or Genealogy of the Saints. Of this last there are two different transcripts; it is a long poem containing the history of the saints of Ireland, and has been attributed to Sealbhach, the secretary of King Cormac Mac Cuillenan, who flourished at the end of the ninth and beginning of the tenth century. One of these copies was transcribed at the Convent of Donegal, on the 25th of April, 1636, out of the parchment book of Maurice Mac Torna O'Mulconry; the other was copied on the 28th of the same month and year, and at the same place, out of the book of Leacain of Mac Firbis. The Feilire of Aenghus was transcribed 9th February, 1630, from a copy made in the year 1534, by Jeremiah O'Mulconry. The Martyrology of O'Gorman and the Martyrology of Tallaght appear to have been copied from a much more ancient MS., which is frequently called by our author, "the old parchment MS.," although its precise age is not specified. Neither is the date of the present transcript particularly given, although the attestation prefixed to it, subscribed by Fearfeasa O'Mulrequest, made application to the Government of Belgium, must be regarded by him as a personal favour granted to himself, on the part of that distinguished nobleman, still he could not but feel that it was a favour which no private individual, as such, had a right to ask, and which was accorded to him in consequence of the official relation in which he had the honour to stand to the Academy. He trusted, therefore, that there would be no impropriety in his moving the Academy, as the body whose especial duty it is to watch over and collect the authentic sources of Irish history, to return public thanks to His Excellency the Lord Lieutenant for his kindness in procuring for Ireland the use of these records, and also to the Belgian Government, and the directors of the Burgundian Library at Brussels, for their very great liberality in lending the MSS., and permitting them to be transported to so great a distance for the purpose of being transcribed.

It was Resolved,—That the thanks of the Academy be given to His Excellency the Lord Lieutenant for his kindness in exerting his influence with the Belgian Government to procure the use of these MSS. for Irish scholars, and the permission to have copies of them made.

Also,—That His Excellency be requested, in returning the MSS., to convey the thanks of the Academy to the Belgian Government, for their very great liberality in permitting the MSS. to be transported to so great a distance for the purpose of being transcribed.

By permission of the Academy, Mr. Clibborn, the curator of the museum, read a letter addressed by him to the Secretary, containing observations made to him by travellers visiting the museum, noticing the similarity of various articles found in Ireland to ornaments actually in use in other countries.

JUNE 10TH, 1850.

), D. D., PRESIDENT,

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SHELF MARK 534.1.D50
BORROWER'S SURNAME GERLOFF
INITIALS S.I.M.
AUTHOR Wilde
TITLE Cat Nat Mus Antiq.
DATE & VOL. NO. 1863
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ADDRESS 9 Mill
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* A full account of this MS., and of the circumstances under which it was purchased by Professor Mac Cullagh, will be found in the Preface to the volume, as published by the Irish Archæological Society.

"They were discovered about two and a half feet under the surface of a shallow bog, in the townland of Hillswood, parish of Kilconnell, county Galway; they were found stuck in a bunch in the ground, with the points down. No other relics appeared near them.

"I am yours very truly,
"G. W. Hemans,
"*Chief Engineer.*

"*Edward Clibborn, Esq.*,
"*Assistant Secretary, R. I. A.*"

Rev. Dr. Robinson gave an account of a new anemometer.

He would not have been induced to add another to the numerous instruments of this kind already invented, but that he thought an exposition of the principles which guided him in its construction might be of use. The time, too, is auspicious, when, under the guidance of the President, we are forming an association to study the meteorology of Ireland. That, he hoped, was an example which would be widely followed, as in a most brilliant instance. Dr. Lloyd, in establishing the Dublin Magnetical Observatory, gave the first impulse to that splendid course of magnetic investigation, which is one of the proudest achievements of the present century. Other branches of meteorology have been brought to high perfection, but anemometry, one of the most important and closely connected with all the rest, is far in the back-ground,—not from neglect. Almost in the dawn of modern science we find Derham and Hooke engaged with it; and from them to the present day, a succession of instruments, many highly ingenious, show that it has been zealously, if not successfully cultivated. Yet it has borne but little fruit, because, as he thought, a wrong track had been followed in observation. What we want to know respecting wind is with its direction) its motion—the space through which the particles of air are displaced. Instead of this, philosophers had observed the pressure, which is only useful as a means of giving the velocity. To this most of the anemometers on record were destined. They may be reduced to three classes. The first, extending from Hooke's to that which the President has recently constructed, consist of windmill vanes, made to face the wind by a vane or other contrivance, and acting against some graduated resistance which measures the pressure; the second, invented 100 years ago by the celebrated Bouguer, long used by a former illustrious President, Mr. Kirwan, and recently re-invented and brought into extensive use by Mr. Ossler, consists of a square plane, which, when exposed to the wind, compresses a spiral spring; and lastly, those which like Lind's, measure the pressure by the column of fluid which it can support. All these are open to the following objections:—First, their indications are most irregular. Wind is not a uniform rush of air; it is irregular to a degree which he could scarcely credit when he began his experiments. A river in flood, with its rapids, counter-currents, and eddies, gives but a faint idea of it; it may be likened to a bundle of filaments moving with all possible motions and contortions. Under such circumstances the pressure varies excessively. He had seen Lind in three or four seconds range from 0 to 3 inches, and, after long watching, could form no guess as to the true measure. In fact, the relative variations of pressure are twice those of velocity. And this innate source of irregularity is increased by the veering of the wind acting now full and now obliquely. It is also exaggerated by the inertia of the moving parts, which carries them beyond the place of balance. Secondly; in none of them can the relation between pressure and velocity be determined but by trial. In most, if not all, that relation is not constant. He insisted on this, because velocities deduced in the common way, from Ossler's gauge, were often one-third too great. Thirdly; it was of the utmost importance that these instruments should be self-registering. Now he showed, that the mean velocity for any time cannot be concluded from the mean pressure, even when the relation between them is known. However, space measures were not entirely neglected. Lomonosoff, in 1749, contrived one which, by an ingenious arrangement, recorded the quantities of wind that blow from each point. Mr. Richard Lovell Edgeworth made one in 1783, which, though invented for another purpose, was used as an anemometer. It was a set of windmill vanes, revolving once for each foot of wind, and the turns reckoned by that beautiful contrivance now called the Cotton Counter, the invention of which is attributed by Willis to Dr. Wollaston. Dr. Wollaston, however, had seen this very instrument, of which he exhibited the fragments. It was made to measure the ascent of a balloon, and was used for this purpose by our countryman Crosby, in his perilous adventures in 1785, being saved by him in the sea. Woltman's hydrometric fly was proposed by him in 1790; but the person who first perceived the full advantages of this measure as an integral instead of a differential, and established its superiority in public estimation, was Dr. Whewell. This instrument, which was shown in Dublin to the British Association in 1835, recorded space and direction. It was used by many here—by Captain Larcom, but above all by that accomplished observer, Sir W. Snow Harris. He, in a most striking communication, in 1842, to the body just mentioned, gave his result, and at the same time pointed out some defects in the instrument, which led Dr. Robinson to turn his attention to the subject. In the following year he constructed the principal parts of the new anemometer, and has ever since been engaged in improving it. The principles which guided him were:

First. It should be so powerful, that friction can only slightly retard it.

Second. So large that it may include in its range a large assortment of aerial filaments, and thus give an average measure.

Third. It should move slowly, so as to require little wheel-work to bring down the space to the size of a sheet, and not be liable to rack itself to pieces.

Fourth. Should not require to be turned to face the wind.

Fifth. All made on the same model should tell the same story, without any trial or adjustment.

The four last decide against vertical windmills, and Dr. Robinson used an excellent form of the horizontal one suggested to him by Mr. Edgeworth, who once showed him the covers of a child's globe attached to a rod, and revolving in the wind by the excess of pressure on the concave and convex surfaces. He suggested that such a mill might be of economic use in many cases, particularly in drainage, as it required no care; and he referred to experiments by Dr. Corrigan and Mr. Bergin, where it did good work in pumping. He showed a model of it, and explained its action. Hydrodynamics are rather faithless as to impulses on oblique or curved surfaces; but in this case there appears to be a compensation in the errors of the theory, and it gives results surprisingly near those of actual experiment. He gave a sketch of the theory, showed how its constants were determined by experiment, of which in particular the resistance on the concave is four times that on the convex, and stated the experiments which gave the relations between the velocities of the wind and the centre of the hemispheres which act as vanes. Both concur in establishing the striking fact, that (except so far as friction interferes) the wind moves exactly three times as fast as the vanes.

He then described the instrument. The four hemispheres are a foot in diameter; their centres describe twelve feet in each revolution. It was necessarily of great height, sixteen feet, to clear the domes of the observatory, which has much increased its weight, twenty-four pounds, and with it the wear and friction. It was an old saying, "as swift as the wind," which, however, will not hold now! A train only as swift as the wind would be a "slow coach," for the average speed of several years is but ten miles an hour. That, however, gives 1500 revolutions per hour, and no support of the lower pivot stood long; hard steel was replaced by stones. He showed an agate cup which was actually drilled after a year's work, and a sapphire which failed after two. At last he supported it entirely above on five balls of bronze, which bear both the vertical and lateral pressures. After a year's use they showed no signs of wear (they must be oiled), and the friction is but 1-300th of the load, being but 53 grains, of which 21 belong to the mill and 32 to the clockwork used in recording the observation. He described that clockwork. Two engraved circular papers are made to revolve; one by a direction vane, as the wind veers, the other by the windmill, at such a rate, that it turns one degree for every mile traversed by the wind, or once for 52,800 revolutions of the mill. The necessary train for this was arranged by one whose premature death is a heavy loss to science, the late Mr. Richard Sharpe. The time is recorded on these papers by pencils moved by the clock at the rate of six inches in twelve hours. That motion, combined with the space rotation, traces on its paper a spiral, contrasting most powerfully with the blurred and jagged stripes of pressure gauges. The direction-record is a sector shaded by the pencil, whose breadth depends on the veering of the wind. This, if exhibited in its full extent, would be very unsightly; and he described various contrivances to lessen it, in particular that used by the President, a supplemental windmill, which acted whenever the wind was oblique to the plane of its rotation, and turned the whole instrument. Dr. Robinson's arrangement is also very effective. In the first place the motion is communicated from the vane to the paper by a long spiral spring, in bending which many of the momentary changes are entirely expended; secondly, a large fan, like that of a blowing machine, exposing about sixteen square feet, and very light, is connected with it by a rapid speed. This moves with the least impulse, if time be given, but presents great resistance to any rapid movement. The two reduce the excursions three-fourths. But he thought it would not be desirable to remove them entirely, even if possible, because he has found that this is a distinctive character of some winds, independent of their force. It is always connected with a tempestuous roar, which gives an exaggerated impression of their force; and some of the heaviest gales he has observed were comparatively noiseless. He then showed three of the sets of diagrams; one, of April 18th, the day of the storm which did such damage in Dublin, had nothing remarkable, except that from 3 to 5 there was a great change of direction to the eastward, and return to the original point, with a sort of unsteadiness that seemed to mark some struggle. The second was a gale on December 15, 1848, in which 516 miles in twelve hours were recorded. In the hour from 2 to 3, sixty-one miles were passed; and during two minutes and a half of it the velocity was at the rate of 105½ miles per hour. This was a cyclone, or circular storm. But a still finer specimen of that was afforded by the third, in which 380 miles in twelve hours was marked, but the direction changed nearly through two entire circumferences.

He should have detailed the mode of combining the results thus obtained; but he felt he had already trespassed too long on their patience. He thanked the Academy for their indulgence, but referred it to the interest which they took in whatever tended to advance physical inquiry. He did not fear to be met by any body guided by such a President, much less by the Royal Irish Academy, with the utilitarian question, "Of what use is all this?" "Even on that ground we might encounter an objection. If, as in the case of the tides, we succeed in working out a theory of the winds, it would have a high commercial value. And why not? We know many of their causes, the temperature, the vapour, tension, the electricity of the atmosphere. We want only the anemometric facts to guide us to laws. Even the little that has been done in the last few years, respecting cyclonic storms, has given birth to a system of hurricane navigation, that has saved British property and British life to an incalculable amount. But I feel that you think, with me, that we should disgrace ourselves if we took such humble ground. We hold that whatever adds to true knowledge, whatever widens the grasp of enlightened intellect, is precious; whatever opens a new view of the secrets of divine power and the majesty of creative wisdom is glorious, is inestimable."

Dr. Petrie read an account of the Cross of Cong.

"In offering to the Academy some account of the very interesting remain of antiquity now before us, and which is popularly known as the 'Cross of Cong,' I am but fulfilling a promise made long ago to the noble-minded and highly gifted man by whom it was presented to our institution; and while oppressed with the sad recollections which the performance of this duty naturally awakens, it is a great consolation to me, that I feel the time and the occasion to be peculiary appropriate to my task, and such as he would have himself desired, namely, when we are honoured with the presence at our meeting of the illustrious representative of our gracious monarch in Ireland, the viceroy whom we recognise as the friend of our institution, and the zealous and enlightened supporter of every pursuit and object tending to the social, moral, and intellectual improvement of the portion of the empire placed under his peculiar care.

"It would be wholly unbecoming in one of my humble intellectual station to offer any panegyrical observations on the general character of the eminent man to whom we are indebted for the possession of this remarkable remain, a man whose death has left a blank not easily to be filled, even in this institution of science and learning, and it is happily not necessary that I should attempt it; but, as one who had the happiness to have been honoured for many years with his intimacy, or, as I may say, his most affectionate regard, it will not, I trust, be deemed presumptuous if I allude and endeavour to do justice to those peculiar features of his mind which led him to present this valuable monument of antiquity to our Academy, and the possession of which obtained for him the affections of many who might otherwise have only reverenced him for his acquirements and genius. I allude especially to that large capacity of mind which enabled and led him to place a just value upon knowledge of every kind, however foreign to his own immediate studies and pursuits, and that characteristic feature of a noble human heart, an ardent love of country, generating an impassioned zeal for its advancement and welfare: I repeat that it was to the existence of such qualities in Dr. M'Cullagh that the Academy owes their acquisition of this historical memorial, a memorial in the possession of which any civilized community might well feel proud.

" But, to understand and appreciate the value of this gift to the Academy, it will be necessary to offer a few words on the origin and formation of the museum of which it is the most valuable and interesting feature.

" When I had the honour to be elected a member of this, the highest intellectual institution of Ireland, I found it, as I may well say, without a library and without a museum, without both of which, according to my young thoughts, such an institution was very imperfect; and with, perhaps, something of the rashness of youth, and particularly on my becoming a member of the Council, I applied my mind to the effecting of objects which appeared to me so desirable. At this time the books of the Academy, which were preserved in a room at the top of the house, in addition to three valuable Irish MSS., consisted almost exclusively of a collection of old mineralogical works, which had been bequeathed to the Academy by one of its illustrious Presidents, the celebrated Mr. Kirwan; and their antiquities, of a few uncared-for remains, lying on the dusty floor of the room in which these books were kept. It was these scanty materials that formed the nucleus of the library now so rich in its stores of manuscript Irish literature, and of its museum, of which it is not, perhaps, saying too much that, in its way, though only in its infancy, as I conceive, it is unequalled by any collection in Europe.

"It is not to be supposed that in a body constituted as this Academy is, for the advancement of studies and interests, which many would be likely to conceive to be not only distinct but even hostile to each other, it is not, I say, to be supposed that the objects on which my mind was bent could be carried out without a strugle and a contest. That struggle was in truth a hard one, and though I had the generous support of many of the most distinguished men in the Academy, and of these I feel it my duty to acknowledge my obligations to Sir William Betham, as one of my most zealous and efficient aiders, it is due to the memory of Dr. M'Cullagh to state, that, but for the sustainment which in the furtherance of these objects I received from his great influence, intelligence, and energy, they could never have been effected to any considerable extent. It was expressly to forward these objects in the Academy, by a splendid example of liberality and zeal, that Dr. M'Cullagh had this cross purchased and presented it to the Academy. Having some years previously, during a tour in Connaught, had an opportunity of seeing this beautiful remain, I communicated to my friend my opinion as to its great historical interest and value; and, without having ever seen it himself, or having received any further information relative to it than that which I had communicated to him, he, who could not be called a rich man, determined, if possible, to become the purchaser, and this without any regard to its cost, even though it might have been five times the amount of that considerable sum for which it was obtained.

"I am aware that there are still in this Academy, as there have been, no doubt, from its foundation, men of distinguished learning and celebrity in their own pursuits, who will not sympathize in the opinions and objects which I and others have so ardently endeavoured to uphold; and that there are others, not less eminent, who, without going so far as to express hostility to these objects, maintain that the formation of an antiquarian museum and a library of the ancient literature of the country should never have been attempted or be continued by a body so poor as the Academy unfortunately is. But it should be remembered that it is not usually the rich men or the rich institutions that effect the most useful and noble objects, and that there is a poverty of the mind which is more fatal to the success of difficult undertakings than even that of the purse. And it appears to me that, with such small pecuniary means at our disposal, we who have formed such a collection of our ancient literary remains, and still more, who in our national museum have done that which has not yet been attempted in wealthy England, have given a striking evidence of this fact.

"And I would ask of those who still are of opinion that the carrying out of these objects is of no value to the country, is it of no value that in a country long torn by faction and prejudice, and apparently lapsing year by year into deeper barbarism, we have attracted into our body, by the cultivation of these pursuits, the intelligent and sober-minded of all shades of opinion, and made them known to and esteemed by each other?—that, in a country without a national literature, and in which the history of the past was only referred to through a distorted medium to serve the purposes of faction, the cultivation of these pursuits has led to a true knowledge of our history, never again to be thus perverted? Is it of no value that our collections, literary and monumental, and the uses made of them, have raised us in the esteem of those in the more fortunate portions of the empire, and have made th

Academy known and respected wherever civilization exists? that those collections have attracted, and daily attract visitors to our city?—that, in place of the ignorant trashery of the so-called historical and antiquarian literature of preceding years, we have now the publications of the two Archæological Societies, whose works would do honour to any country, and are most essential to the knowledge of the history and literature of Europe?—that we also see yearly issue from our native Press works upon our local histories, whose typographical beauty is only surpassed by the excellence of the matter contained in them? And, again, is it of no value that our museum has been the means of disseminating a better taste in the fine arts, and given birth to new branches of the more elegant trades in our city? And is it of no value that at the eleventh hour we have snatched from destruction, and placed in a safe asylum, where they are accessible to the world, so much of the scattered remains of our ancient arts and literature?

"And yet these, after all, are but a few of the results which have followed, and are sure to follow the formation of these collections. But though I feel that I am trespassing upon the patience of the Academy, there is yet one other result, which, both in its application to the past and to the future, it would be culpable if I did not notice. I would remind the Academy that it is to these collections we owe the honour conferred upon us by that enlightened and most worthy Prince, who, within the past year, examined and expressed his approbation of them; and that the possession of these collections leads us to look forward with hope that they may prove an object of attraction, and possibly of gratification, to that most illustrious and accomplished lady to whom we owe so much loyalty, gratitude, and respectful love.

"If, then, the effecting of these objects be considered worthy of approbation, as I trust it will by at least the great majority of the Academy, let us never forget, whenever our eyes may rest on this beautiful historical memorial, how much of their success was consequent upon the aid of its donor; and let us hope that as our institution does not, so it never shall want for minds as large, as generous, and as enlightened as his, to sustain and carry on those objects which he deemed so desirable and so worthy of its support. The forming of such collections in Ireland is, in truth, no childish or unworthy pursuit. They are essential not only to the history of Christain civilization since the Roman times, but to the history of that earliest family of the great Indo-Germanic race, who have left the traces of their footsteps in every part of Europe, and found their last refuge in the British Islands.

"Trusting that these prefatory remarks will not be deemed irrelevant to the object I have undertaken, I have now to request attention to the shrine itself, which, as it is before us for inspection, it is not necessary that I should occupy the time of the Academy by any minutely detailed description of it.

"Its history, and the nature of the relic which it was made to enshrine, is, fortunately for us, preserved by legible and intelligible inscriptions, which are carved along its sides. From the first of these inscriptions, which is in Latin, but in the Irish letters, and which is twice inscribed upon the case, we learn that the relic, which was placed beneath the large circular ball of crystal in the centre of the cross, was, as believed to be, no less than a portion of the cross on which the Maker of the world was crucified.

"This inscription reads thus:

"'✠ hac cꞃuce cꞃux ꞇeᵹiꞇuꞃ qua paꞅuꞅ conꝺiꞇoꞃ oꞃbiꞅ.'

"The remaining inscriptions, which are in the same Irish characters, but in the Irish language, preserve the names of the persons who were concerned in the making of the 'ᵹꞃeꞅꞅa,' or shrine of the relic. They consist of four divisions or compartments, and of these the first reads as follows:

"'Oꞃoiꞇ ꝺo Muiꞃeꝺuch u Ꝺubchaiᵹ ꝺo ꞅenoiꞃ Eꞃenꝺ.'

"That is, in English, 'A prayer for Muireadach O'Du

the senior of Ireland.'

“ This inscription, it should be observed, is mutilated by the loss of a part of the moulding which contained three or four words; but there can be no doubt as to what those words expressed, from the inscription which next follows, namely, that the shrine was made for him.

The second division of the inscriptions reads thus:

“‘Oꞃoıꞇ ꝺo Ꞇheꞃꝺelbach u Chonchabhaꞃ, ꝺo ꞃıᵹ Eꞃenꝺ la ꞅa nꝺeꞃꞃnaꝺ ın ᵹꞃeꞅꞅa.’

“Or, in English, ‘A prayer for Turlough O'Conor, for the king of Ireland, for whom [that is, at whose desire or expense] this shrine was made.’

“The third compartment reads thus—

“‘Oꞃoıꞇ ꝺo Ꝺomnull Mac Ꝼlannacan u Ꝺubꞇhaıᵹh, epꞅcop Connachꞇ, ꝺo chomaꞃba chomman acuꞅ chıaꞃan ıca neꞃꞃnaꝺ ın ᵹꞃeꞅꞅa.’

“That is, ‘A prayer for Donnel, the son of Flannagan O'Duffy, bishop of Connaught, and coarb (or representative) of St. Comman and St. Ciaran, under whose superintendence this shrine was made.’ By which we are to understand that this bishop was abbot of St. Ciaran's great monastery at Clonmacnoise, and of St. Comman's monastery at Roscommon, which gave its name to the county.

“ The fourth and last compartment of these inscriptions is not the least valuable, though it only preserves the name of a person of inferior station, that of the artificer who made the shrine, as it proves incontestibly what without it might and probably would have been deemed doubtful, namely, that the shrine was of native workmanship. It reads as follows:

“‘Oꞃoıꞇ ꝺo Maelıꞅu Mac Bꞃaꞇꝺan u Echan ꝺo ꞃıᵹnı ın ᵹꞃeꞅꞅa.’

“ Or, ‘A prayer for Maelisa, the son of Braddan O'Echan, who made this shrine.’

“ Of the different persons whose names are thus recorded, with the exception of the artist or maker, of whom no other account has been found, many historical notices are preserved in our authentic annals; and one of these authorities also records the bringing of the piece of the cross into Ireland, and the making of this shrine for its preservation. It occurs in the Annals of Innisfallen, at the year 1123, the year in which the first General Council of Lateran was held, during the pontificate of Pope Calixtus, and is to the following effect:

"'A bit of the true cross came into Ireland, and was enshrined at Roscommon by Turlough O'Conor.'

"This entry in our annals gives us all the information that is preserved to us in reference to this relic, which was probably the first of the kind that was sent to Ireland, although we are told by O'Halloran of an earlier gift of a piece of the holy cross, by Pope Pascal II., to Murtogh, the grandson of Brian Boroimhe, and Monarch of Ireland, 'with opposition,' in the year 1110; and that in honour of this piece of the cross, the Abbey of Holy Cross, in Tipperary, was founded about sixty years afterwards. But, as O'Halloran gives us no authority for this statement, and though a piece of the cross was preserved there, and still exists, it is more probable that it was not sent into Ireland till the time of the erection of that monastery, which was in 1169.

"It is scarcely necessary to state that it was during the reign of Turlogh O'Conor, and about the period that this piece of the cross was received in Ireland, that successful efforts were made by the Papal See to obtain a reformation in church discipline, and a more absolute domination in ecclesiastical matters in Ireland than it had enjoyed previously; and we may perhaps very fairly suppose the present of this relic to have been a precursor to those agitations in the Irish Church, and look upon it as an historical memorial of those great events which followed.

"Of the life and acts of Turlogh O'Conor, or, as he was called, Turlogh the Great, the person at whose instance this shrine was made, our annals preserve abundant notices. His history is, in fact, essentially that of the country over which he ruled, either as King of Connaught or Monarch of Ireland, for no less a period than fifty years. He was one of those provincial princes whom the Irish historians denominated Rıᵹhe ᵹo bhꝼꞃeaꞅabhꞃa, or 'kings with opposition,' or whose authority was disputed, and who, as O'Flaherty writes, were in possession of sovereign power, though not absolute in regard of the projects laid by rival princes to undermine them. In other words, he was one, and perhaps the greatest, of those bold, ambitious, and unscrupulous men, who, following in the track of the great military usurper, Brian Boroimhe, broke through the principle of legitimate succession which had preserved the monarchy in the Hy-Niall race for a period of 700 years; and thus involved the country in such a state of anarchy, disunion, and feebleness, that it became an easy prey to the ambition of the second Henry, in the reign of his feeble and less talented son, Roderick.

"His history is thus sketched by his descendant, Charles O'Conor, of Belanagare:

"'Turlogh O'Conor was at this time (anno 1150) the most powerful prince of Ireland. He disposed of the two provinces of Munster to his own liking at several times, availing himself of the virulent wars in that country between the O'Brians and the Mac Carthys. He was also in almost a perpetual hostility with Murchad O'Malachlyn, king of Meath, formerly his father-in-law. Mac Morogh (the king of Leinster) he often subdued, never feared. He had been stopped in his career of power by Murchertach O'Lochlin, king of the North Hy-Niall, but never subdued. He raised the power of Connaught higher than any of his predecessors, reigned over that province fifty years, and died with the character of an able prince in the year 1156.'

"An able prince he was unquestionably, but, as his recorded acts show, a cruel and unprincipled one. In our times we cannot read without a shudder of a father imprisoning one of his sons for a long period, and blinding another. It should be stated, however, to his honour, that he was magnificent and generous, and that he appears to have been a zealous promoter of the arts of civilized life. Of this feature in his character we have evidences in some of the monuments which have remained to us, as the richly adorned church, and stone cross at Tuam, and the beautiful specimen of jewellery now before us. These qualities are thus indicated in the record of his death preserved in the Book of Clonmacnoise, and the works of other annalists :

"'In the year 1156 Tordelbeach O'Conor, king of Connaught, Meath, Brefiny, Munster, and all Ireland, the supreme head of the ranks and nobles of Ireland, the Augustus of the Western Europe, after having distributed and bequeathed all his precious household furniture, that is, his gold and silver vases, gems, and other such like valuables, his studs and cattle, his gaming utensils, his bow, quiver, and all other weapons, excepting his sword, shield, and goblet, with sixty-five ounces of gold and sixty marks of silver, among all and each of the churches, breathed his last at Dunmore, the nineteenth of May, the first of January preceding beginning on a Sunday, and was interred with all funeral pomp in the church of St. Kiaran, at Cluanmacnoise, in the sixty-eighth year of his age, and fiftieth of his reign (from the time that he succeeded his brother Donald, in the year 1106).'

"Of the archbishop, Muireadhach O'Duffy, the eminent ecclesiastic for whose use the shrine was made, our annalists have in like manner preserved many historical notices; and his acts, as recorded, exhibit a pleasing contrast to those of the ambitious monarch, for they are invariably conducive to humanity and peace. He appears, indeed, to have been a truly illustrious person, and in every way deserving of his great reputation.

"As a specimen of his acts, and as showing the uses to which such reliques as this before us were applied in Ireland, I shall quote one or two entries in the Book of Clonmacnoise, as preserved to us in the quaint language of its translator, Connell Mac Geoghegan :

"'A.D. 1136, Rory (or Roderick) O'Conor and Uada

O'Concennan were put under arrest by Turlogh O'Conor, though under the protection of the coarb of St. Jarlath (i. e. the archbishop of Tuam), and of O'Duffy, and of the *Bachall Buee*, or the yellow staff.'

"The relic here called the yellow staff I am inclined to believe was the shrine now before us, and so called popularly from its golden appearance.

"Again, in Mac Geoghegan, at the year 1139:

"'King Terlaugh took his own son prisoner. After that he gave him before upon these oaths and securities following, viz. (his own name was Rory O'Connor, that was afterwards king of Ireland), Moriegh O'Duffie, archbishop, with all the laymen and clergy of Connaught; Teige O'Brien, king of Thomond; Tiernan O'Roirke, king of the Brenie; and Murrough Mac Gille ne-newe O'Fergall, chieftain of Annalie. They all, both clergy and laymen, fasted at Rathbrendan, to get the young prince out of the king's hands, and could not. Also King Terlaugh took Murrough O'Melaghlen, king of Meath, prisoner, after he had agreed with him that each of them would be true to one another, and seek no advantage or hindrance of each other. These were the oaths and sureties that were between them of either side for performance of said agreement, viz.:—The altar of St. Ciaran's shrine; relics Norannagh; two prelates of every severall houses; together with Morrough O'Duffie, archbishop of Connaught; primate of Ardmach; the staff of Jesus, which St. Patrick brought into this kingdom; the cowarb of St. Fechin's bell, and the boban of St. Kevin; by all which sureties and oaths they were bound to each other not to seek advantage either by captivity, bynding, or encroaching upon each other's land, until apparent occasion had appeared to the sureties; and notwithstanding all which Murrough was taken prisoner by K. Turlough, and kept for the space of a month, without any breach of his side, until at last he was enlarged at the intercession of the said prelates and noblemen that were sureties for him, whom they sent with safe conduct to Munster.'

" The death of this distinguished man is thus recorded in the Annals of the Four Masters:

" ' A. D. 1150. Muireadhach O'Duffy, archbishop of Connaught, the arch-senior of all Ireland in wisdom, in chastity, in the bestowal of gifts and food, died at Cong on the 16th day of May, at the festival of St. Brendan, in the seventy-fifth year of his age.'

" The bishop, whose name is preserved in the third compartment of these inscriptions, as the person under whose superintendence the shrine was made, was also of distinguished celebrity in his time, and was, no doubt, of the same family with, and intimately related to the senior of Ireland.

" Like the former, he was archbishop of Connaught, and also bishop or abbot of Clonmacnoise and Roscommon. His death is thus recorded in the Book of Clonmacnoise, as translated by Mac Geoghegan :—

" ' A. D. 1136.—Donnell O'Duffy, archbishop of Connaught, and coarb of St. Ciarin, immediately after celebrating mass by himself, died, and was buried on St. Patrick's Day, at Clonfert, where he died and celebrated the said mass.'

" I should observe that it appears from our annals that this family of O'Duffy in Connaught appears to have been peculiary ecclesiastical, or devoted to religion. The father of Donnell, that is, as the inscription states, Flanagan O'Duffy, was, as appears from our annals, abbot of Roscommon, and died in 1097. Another of his family, Florence O'Duffy, was bishop of Elphin, and died at Cong in 1168. Cadley, or Catholicus O'Duffy, was archbishop of Connaught, and attended as such at the synod held at Clonfert in 1170; and from an inscription on the market-cross, still remaining at Cong, which has not hitherto been deciphered, we find that it was erected by two of this name, who were abbots of that place.

"Of the history of this shrine, subsequent to the time of its fabrication, our annalists are silent, and even the traditions of the place where it had been so long preserved have been erroneous and of no value. According to the account given me by Father Prendergast, the last abbot of Cong, and last representative in Connaught of the Augustinian Order, the cross was brought into Ireland and deposited at Cong, with the monks of that order, by St. Patrick, though the order did not exist till two centuries later, and was not established in Ireland for many ages afterwards. This, he said, was the historical tradition connected with it, and which he believed to be true; and though I endeavoured, by reading to him the inscriptions carved upon the shrine, to convince him that such tradition was altogether erroneous, I found it impossible to make any impression upon him. But the want of any historical accounts of this shrine for so long a period is of little importance, as, from the fact recorded of the archbishop for whom it was made, that he died in the monastery of Cong, we may reasonably infer that the shrine was left by him in that great religious establishment, in which so many of his name and family subsequently ruled, and that it must have been preserved there till the final extinction of the Augustinian Order, as connected with Cong, in our own time. Father Prendergast further stated that the shrine, with a great number of the ancient manuscripts of the monastery, at the dissolution of the monastic houses in Ireland, had been concealed in an old oaken chest in a cottage of the village, and so remained till he became abbot, and took possession of them. But in this, also, he was probably in error, for the shrine must have been seen by the learned Humphrey Lloyd, during his tour in Connaught at the commencement of the eighteenth century, as he quotes and translates in his Archæologia, published in 1709, the inscription relative to Muireadhach O'Dubhthaigh as being carved upon it; and this inscription is also given by the learned Dr. O'Brien in his Irish dictionary, though it is very probable that the bishop only quoted the passage from the work of the former. And hence it appears to me to be more probable that the concealment of the shrine and manuscripts,—which manuscripts, I regret to say, were subsequently destroyed,—

only took place and became necessary during the severe operation of the penal laws which were enacted in the reign of Anne.

"I had intended to offer some observations to the Academy, on the value of this remain as a work of art, of native manufacture, anterior to the occupation of the country by the Anglo-Normans; but, having already trespassed too long on the time of the Academy, I shall defer such remarks to some future time, and conclude by expressing my thanks for the patience with which they have listened to this very hastily drawn up communication."

JUNE 24TH, 1850.

THE REV. HUMPHREY LLOYD, D. D., PRESIDENT, in the Chair.

RESOLVED, on the recommendation of the Council,—That the sum of £50 be placed at the disposal of the Council to purchase antiquities.

To which the following amendment was added :—"And that in making this grant the Academy desires to express its opinion that the existing liabilities, if any, incurred by the Committee of Antiquities, should be discharged previously to the purchase of any further articles of antiquarian interest."

The President read a letter from Jacob Grimm, who was recently elected an Honorary Member of the Academy, returning thanks for the honour conferred on him. The letter stated that the learned writer had been engaged in the study of the Irish language, with a view to the comparison of it with other European languages.

The Rev. Dr. Todd exhibited a Sikh manuscript, called the Gorund, the gift of Joseph Burke, Esq., Assistant Surgeon of the 40th Regiment, to the library of the Academy. An accompanying letter from the donor stated that the manuscript had been found on the battle-field of Aliwal, one of the recently fought Indian engagements. It was in the Sanscrit character, quite perfect, and in excellent preservation.

The Rev. Dr. Todd read a letter from the Rev. Dr. Spratt, forwarding a donation to the museum of a carved figure of the Virgin and child, found at Donabate; also an antique bell, which had been discovered in Kildare, beneath the site of an ancient building, in sinking the foundation for the chapel.

The President communicated the second series of the results of observations made at the magnetical observatory of Trinity College.

The Rev. Samuel Haughton, F. T. C. D., read a paper on an instrument termed a friction sledge, for stopping railway carriages at termini or side lines, invented by Mr. Wilfred Haughton, and containing an account of some theoretical deductions drawn from accurate experiments made with the sledge, by permission of the Dublin and Kingstown Railway Company, at the Ringsend Docks.

Mr. Hancock made some remarks on the great expense of obtaining protection for such inventions, owing to the present state of the law of patents. The cost of taking out a patent for the invention of Mr. Haughton would be, in England, £110; in Ireland, £135; and in Scotland, £75; being above £300 altogether. Although an investigation would answer for the three countries, yet the law of patents was such that inventors would have to take out three patents. The expense of a patent was greater in Ireland than in any other state in the world; and it arose not necessarily from the nature of the thing, but from the mode of paying certain public officers. This defect in the law of patents was a very great impediment in the way of inventors receiving the just reward of their exertions. It resulted from the supposition that patents were injurious to the community, and that the more they were restrained the better. He believed that they were most beneficial to the community, because they prevented inventive genius from being wasted away. In the absence of a system of patents inventors would be disposed to keep the fruits of their originality secret; and consequently they would be lost to the public. Therefore, he thought that a more perfect system of patents, by which every discovery would be secured to the community, and the just reward of his exertions insured to the discoverer, was much to be desired.

Dr. Madden read a paper containing an account of a proposal made in 1617 to apply magnetism as a means of communicating intelligence, by a method resembling the electric telegraph.

"The attention turned to the properties of the magnet, by our knowledge of the advantages derived from the mariner's compass, led to the first speculation on the possibility of the same agency being made a means of rapidly communicating intelligence between persons widely separated. The project in Latin poetry, of the magnetic telegraph, of the Jesuit Strada, conceived 233 years ago, was the precursor of the electric telegraph of our times. The application of the peculiar properties of the magnet to the purpose of navigation is claimed for a Neapolitan of the thirteenth century, of the town of Melfi, in the Terra di Lavaro. The first European navigator, however, who visited the Indian seas, had not to teach the Arab and

Chinese mariners the use of the compass. Osorius, in the first book of his 'History of Portugal under Emanuel,' gives a long account of the marine needle which Gama, in his first voyage, found in use at Mosambique (in 1498), in the Arab trading vessels which frequented the principal parts of that island. 'These people,' he says, 'aided themselves then in their navigation with certain instruments which our pilots call marine needles.' He then goes on describing the Arab compass, which in no very material respect seems to have differed from that now in use. At the end of this minute description, he adds:—'These Arabs made use then of such needles and marine charts, by the means of which they knew with certainty the situation of maritime places according to the lines drawn on such charts. They observed also with quadrants the height of the sun, and the distances of places from the equinoctial line. In brief, they were so well furnished with everything necessary for navigation that the pilots of Portugal had hardly anything to teach them in the art of navigating.' Humboldt, in one of the most recent of his publications, informs us that 'More than a thousand years before our era, at the obscurely known epoch of Codrus, and the return of the Heraclides from the Peloponnesus, the Chinese already employed magnetic cards, on which the figure of a man, whose moveable outstretched arm pointed always to the south, guided them on their way across the vast grassy plains of Tartary; and in the third century of our era, at least seven hundred years before the introduction of the compass in the European seas, Chinese vessels navigated the Indian Ocean with needles pointing to the south.'* We read, in a work published in 1617, of a singular invention, very similar to that of the electric telegraph, described in some remarkable Latin verses said to have been recited by the celebrated Cardinal Bembo, at a festival got up in honour of the return to Rome of an illustrious personage, Hieronymus Alexander, previously to his investiture with the purple. The author of this work, the learned Jesuit Famiano Strada, filled the office of master of rhetoric in Rome for fifteen years. The work entitled 'Prolusiones Academicæ' was written while he filled that office in 1617. He died in the year 1649. The remarkable account of the uses to which the magnet might be turned occurs in the second book (p. 233 of the Oxford edition published in 1745). The discovery of those uses, and the verses descriptive of them, he attributes to Cardinal Bembo. The pageant where those verses were recited he states was performed before Leo X. The most celebrated poets of antiquity were represented in it by eminent Roman men of letters of that day, and their several styles were imitated in poetic pieces purporting to have been improvised on that occasion by Cardinal Bembo, Jovianus Strozzo, Naugerius, Parrhasius, Sadoletus, and Castilione. The pieces, however, are evidently the compositions of Strada. But it is to be observed, he narrates this exhibition and display of intellectual prowess as realities which had been communicated to him by his friend Alexander Burgius, to whom they had been related by Jerome Amaltheus, who had heard them from his intimate acquaintances, Bembo, Sadoletus, and Naugerius. Bembo, it may be observed, went to Rome, and became secretary to Leo X. in 1512, and died there in 1547, just seventy years before Strada published his Prolusiones. In the 115th and 21st numbers of 'The Guardian' there are two papers by Addison on critics and criticism, wherein he refers to the 'Prolusiones' of the learned Jesuit Strada, as 'one of the most entertaining, as well as the most just piece of criticism he ever read.' In those numbers he speaks of the pageant above referred to. 'It is commonly known,' he observes, 'that Pope Leo the Tenth was a great patron of learning, and used to be present at the performances, conversations, and disputes of all the most polite writers of his time. Upon this bottom Strada founds the following narrative.' The writer then describes the performances on the banks of the Tiber, near a villa of the Pope, on an artificial mount intended to represent Parnassus, and constructed so as to resemble a floating island in a lake. '*Strada*,' he continues, 'in the person of Lucretius, gives an account of a chimerical correspondence between two friends by the help of a certain loadstone, which had such a virtue in it that if it touched two needles, when one of the needles so touched began to move, the other, though at never so great a distance, moved at the same time and in the same manner.' He tells us that two friends, being each of them possessed of one of those needles, may make a kind of dial-plate, inscribing it with the four-and-twenty letters in the same manner as the hours of the day are marked upon the ordinary dial-plate, and they fix one of those needles on each of these plates, in such a manner that it could move round without impediment, so as to touch the four-and-twenty letters. Upon their separating from one another into distant countries, they may agree to withdraw themselves punctually into their closets at a certain hour of the day, and to converse by means of this their invention. Accordingly, when they are some hundred miles apart, each of them may shut himself up in his own closet at the time appointed, and immediately cast his eye upon the dial-plate. If he had a mind to write anything to his friend, he directed his needle to every letter that formed the words which he had occasion for, making a little pause at the end of every word or sentence, to avoid confusion. The friend in the meantime saw his own sympathetic needle moving of itself to every letter which that of his correspondent pointed at. By this means they talked together across the whole Continent, and conveyed their thoughts to one another in an instant over cities or mountains, seas or deserts.' *

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*Cosmos, page 169.

"But Addison does not profess to give a literal translation of those remarkable lines, and without that it is impossible to form an adequate idea of the import of some of them. The following version of them is rendered as faithful to the original as the abstruseness of some passages would admit of. And it is likewise well to remember that similar scholastic fooleries to those described by Strada were undoubtedly played at Rome in the presence of Leo the Tenth, and were shared in by several of those very eminent scholars whom Strada has introduced into his 'Prolusiones.' For convenience of reference the translator directs attention to the original Latin lines, beginning with the one—

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* Guardian, No. 119, vol. ii. pp. 213, 214.

'Magneti genus est lapidis mirabile,' &c.

'The nature of the magnet stone is wondrous; if to it you approach many particles of iron or iron styles (*stylos*) they not only derive from it a force and motion by which they ever strive to turn themselves towards the Great Bear constellation, where it shines near the pole, but also with a strange connexion and manner (of action) towards each other you will see as many styles as have touched that stone all jointly combine in one movement and one place; so that if perchance one of these be moved at Rome, the other at that movement, though it be far distant, turns itself by a secret bond of its nature. Now, then, if you wish your distant friend, to whom no letter can come, to know anything, take a disc (or dial), then write round the edge of it the letters of the alphabet, in the order in which children learn them, and in the centre place horizontally a rod which has touched the magnet, moveable so that it can touch whatever letter you wish. On the model of this you will make another disc, marked with a similar margin, and armed with an indicator of iron, which has received the movement of the magnet from that other iron. This disc let the friend about to depart take with him, and agree beforehand at what time, and on what days, he will examine whether the rod trembles, and what letters it points to with its index. These matters being thus arranged, if you desire privately to speak to the friend whom some shore of the earth holds far from you, lay your hand on the globe, turn the moveable iron—there you see disposed along the margin all the letters which are required for words; hither turn the indicator, and the letters, now this one, now that one, touch with the style, and whilst you are turning the iron through them again and again, you separately compose all the ideas in your mind. Wonderful to relate, the far-distant friend sees the voluble iron tremble without the touch of any person, and run now hither, now thither; conscious he bends over it, and marks the teaching of the rod, and follows reading here and there the letters which are put together into words; he perceives what is needed, and learns it by the teaching of the iron. And, moreover, when he sees the rod stand still, he, in his turn, if he thinks there is anything to be answered, in like manner, by touching the various letters, writes it back to his friend. Oh! may this mode of writing prove useful. Safer and quicker thus would a letter speed, nor have to encounter the snares of robbers or impediments of retarding rivers. A prince might do the whole business (of his correspondence) for himself with his own hands. We, children of scribes, emerging from the inky flood, would then hang up our pens in votive offering on the shores of the magnet.'—Bembo having thus concluded, we are told his verses were largely commended for the excellence of their imitation of the style of Lucretius, but for nothing more. Strada, no doubt, composed all the poems in his 'Prolusiones' that illustrated the styles of the different ancient poets who were represented on this occasion; but the question is, what foundation was there in fact for the subject of magnetic influence and its applicability to telegraphic purposes ever having been improvised on any occasion by Cardinal Bembo in presence of Leo X.? Is there any trace of this embryo of a great fact struggling into form before its time, any intuitive perception, however vaguely expressed, of the possibility of its being, to be found in the writings of this eminent man? It matters little, however, whether Strada or Bembo originated the idea. There is a sufficiently long interval between the times of either and our own, to make a marvel of the conception even of the possible accomplishment of a mighty plan for conveying thoughts, with the rapidity of lightning, thousands of miles over extensive regions, by agent intangible and subtle, rendered manageable by a simple mechanism that could be put in the hands even of a mere child. The interval might have been longer than two centuries between Strada's idea and the realization of it by Lomond, had Galvani's experiments not led to an enlarged knowledge of electricity, and to a reasonable conjecture that magnetism was a subordinate form of electricity, as well as light and heat. Strada's conception of the feasibility of employing the agency of magnetism for the transmission of intelligence could hardly fail to be suggestive of similar projects and appliances; and these we find practically carried into execution in the construction of the first electric telegraph we have any account of,—that of a French mechanic, made in Paris about sixty years ago. I find an account of this first practical application of electricity to telegraphic purposes noticed in Mr. Arthur Young's Travels in France, in the years 1787, 1788, and 1789. At page 135 of the first volume, in referring to the various scientific inventions he had seen in France, he observes:—'Many of the discoveries that have enlarged the bounds of science have been the result of means seemingly inadequate to the end,—the energetic exertions of ardent minds bursting from obscurity, and breaking the bonds inflicted by poverty, perhaps by distress. I visited (at Paris) M. Lomond, a very ingenious mechanic, who has made an improvement of the jenny for spinning cotton. . . . In electricity M. Lomond has made a remarkable discovery: you write two or three words on a paper, he takes it with him into a room, and turns a machine enclosed in a cylindrical case, at the top of which is an electrometer, a small, fine pith ball. A wire connects a similar cylinder and electrometer in a distant apartment, and his wife, by remarking the corresponding motions of the ball, writes down the words they indicate, from which it appears that he has formed an alphabet of motions. As the length of the wire makes no difference in the effect, a correspondence might be carried on to any distance—within or without a besieged town, for instance—or for a purpose much more worthy, and a thousand times more harmless,—between two lovers prohibited or prevented from any letter connexion.'[*] It is more surprising that such a long interval should have been between the project of Strada and the practical realization of its aims, than that the powers of electricity should have been ascertained to be applicable to telegraphic purposes, whereof that surprising agent, magnetism, had been reasonably conjectured to be a subordinate form, as well as light and heat, and the action of the brain itself a modification of the same intangible and imponderable element. 'If mental action,' says the author of the Vestiges of the Creation, 'is electric, the proverbial quickness of thought, that is, the quickness of the transmission of sensation and will, has been brought to an exact measurement. The speed of light is about 192,000 miles per second. The experiments of Professor Wheatstone have shown that the electric agent travels, if I may so speak, at the same rate, thus showing a likelihood that all the imponderable bodies are ruled by one law of movement.'—(Sixth Ed. p. 294, notes.) It had not, however, been found out for upwards of a century and a half after Strada's death that 'simple electricity may be artificially produced and sent along the nerves of a dead body, exciting muscular movement,' and that it was capable of being similarly transmitted along the wires connected with a galvanic battery, causing motions corresponding to the former movement. Galvani's first publication respecting his new discovery, 'De veribus Electricitatis in Motu Musculari Commentarius,' appeared in 1791. His death took place in 1798. The electric telegraph, in short, may be regarded as having its type in that wonderful corporeal mechanism which transcends all other miracles of nature, and it may be considered as existing in embryo in Father Strada's poetical project of an apparatus for the rapid communication of our ideas by means of magnetic motions duly regulated and determined."

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[*] Young's Tour, vol. i. p. 79. 2nd edition, 4to.

APPENDIX.

No. I.

METEOROLOGICAL JOURNAL,

COMMENCING

1st JANUARY, 1847, AND ENDING 31st DECEMBER, 1847,

BY

GEORGE YEATES.

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The instruments employed, and the general circumstances of the mode of observing, have been described in the preliminary observations to the Tables of the year 1843, in the 2nd volume of the Proceedings of the Academy, Appendix V.

JANUARY.						FEBRUARY.						MARCH.					
	Thermom.		Barom.	Rain.	Wind.		Thermom.		Barom.	Rain.	Wind.		Thermom.		Barom.	Rain.	Wind.
	Max.	Min.					Max.	Min.					Max.	Min.			
1	46°	43°	30.338	.040	E. by N.	1	38°	28°	29.764	.050	N. W.	1	40°	30°	30.400	. . .	E.
2	44	38	30.019	. . .	E.	2	38	32	30.000	. . .	E.	2	43	39	30.550	. . .	N. E.
3	41	34	29.616	.010	S. E.	3	38	32	30.034	.020	E. N. E.	3	43	35	30.558	. . .	N. E.
4	41	35	29.444	. . .	E. N. E.	4	40	29	30.200	.010	W. N. W.	4	46	40	30.484	. . .	N. E.
5	47	38	29.626	.320	E. S. E.	5	44	34	30.148	.025	W.	5	44	39	30.412	. . .	N. E.
6	48	41	29.914	.700	E.	6	47	40	29.649	.060	W. N. W.	6	47	40	30.284	.002	N. E.
7	48	43	29.836	. . .	E.	7	50	32	29.468	.020	W.	7	44	35	30.168	. . .	N. E.
8	48	43	29.900	.020	E. by S.	8	33	22	29.550	.200	W.	8	46	36	30.250	. . .	N.
9	45	40	30.100	. . .	N. N. W.	9	33	22	29.540	.050	N. W.	9	47	35	30.134	. . .	N. W.
10	44	38	30.054	.006	S. E.	10	32	24	29.640	.015	N. W.	10	44	32	29.992	.030	N. E.
11	40	37	29.990	. . .	S. E.	11	34	20	29.779	. . .	N. W.	11	39	22	30.150	.020	W.
12	42	39	29.876	. . .	S. E.	12	33	19	29.800	. . .	N. W.	12	44	33	30.168	.020	N. W.
13	41	26	29.782	. . .	S. E.	13	28	11	29.900	. . .	N. W.	13	46	39	30.176	. . .	W.
14	46	27	29.800	.006	S. E.	14	48	19	29.500	.120	W.	14	50	33	30.050	. . .	E.
15	49	45	29.724	.010	S. E.	15	51	39	29.250	.200	S. W.	15	54	46	29.700	. . .	S. E.
16	48	30	29.924	.010	S. E.	16	52	37	29.572	.025	S. W.	16	56	47	29.482	.030	S. E.
17	43	34	30.020	.030	E.	17	51	39	29.572	.160	S. W.	17	54	47	29.450	.050	S. E.
18	42	36	30.000	. . .	S. E.	18	56	41	29.550	.008	S. W.	18	54	46	29.620	. . .	S. E.
19	42	35	30.050	.050	S. E.	19	51	34	29.834	.520	N. W.	19	56	44	29.350	.015	S. E.
20	39	36	29.890	.090	S. S. W.	20	46	38	29.920	.008	S. W.	20	52	43	29.140	.120	S. W.
21	44	39	29.570	.640	W.	21	51	39	30.100	. . .	S. E.	21	58	45	29.280	.020	S. E.
22	49	43	29.500	.030	S. S. W.	22	54	40	30.184	. . .	N. E.	22	52	33	29.740	.040	W.
23	49	42	29.416	.100	S. W.	23	53	42	30.092	. . .	N. E.	23	53	39	29.532	.060	W.
24	48	39	28.700	.300	W. S. W.	24	46	38	30.084	. . .	E.	24	49	37	29.740	.055	W.
25	48	37	28.884	.120	S. W.	25	44	32	30.060	. . .	E.	25	50	37	29.850	. . .	S. E.
26	48	37	29.114	.010	S. W.	26	44	29	30.032	. . .	E.	26	51	45	29.734	.020	S. E.
27	51	39	29.050	.080	W.	27	39	32	30.072	. . .	E.	27	57	42	29.826	. . .	S. E.
28	46	37	28.960	. . .	W.	28	40	33	30.250	.080	E.	28	51	44	29.640	.200	S. E.
29	46	35	29.238	. . .	W.							29	45	30	29.850	.100	N.
30	46	35	29.544	.026	W.							30	45	30	29.742	. . .	N. E.
31	44	28	29.750	. . .	N.							31	44	30	29.500	.200	N. E.

APRIL.						MAY.						JUNE.					
	Thermom.		Barom.	Rain.	Wind.		Thermom.		Barom.	Rain.	Wind.		Thermom.		Barom.	Rain.	Wind.
	Max.	Min.					Max.	Min.					Max.	Min.			
1	42°	29°	29.392	.180	N. W.	1	52°	35°	29.623	.050	N. E.	1	76°	49°	30.550	. . .	S.
2	42	27	29.400	.040	N.	2	51	38	29.673	.100	N. W.	2	75	48	30.500	. . .	S. E.
3	44	30	29.550	.010	N. E.	3	54	36	29.871	. . .	E.	3	76	50	30.448	. . .	S. E.
4	47	28	29.630	. . .	W.	4	57	38	29.812	. . .	E.	4	76	55	30.362	. . .	N. E.
5	51	39	29.684	.050	N. W.	5	57	42	29.722	. . .	E.	5	73	48	30.370	. . .	N.
6	58	41	29.800	.200	W.	6	53	43	29.500	. . .	E. S. E.	6	65	45	30.200	. . .	N.
7	54	45	29.760	.060	W.	7	64	44	29.450	.080	S. E.	7	61	43	30.153	. . .	W.
8	62	32	29.406	.040	W.	8	55	46	29.410	.230	S. E.	8	61	48	29.861	.040	N. W.
9	55	32	29.684	. . .	N. W.	9	57	45	29.542	.250	S. W.	9	60	44	29.950	.050	W.
10	49	39	29.800	.020	W.	10	62	46	29.664	. . .	S. E.	10	60	49	29.863	.100	W.
11	53	44	29.750	.220	W.	11	58	45	29.600	. . .	N. E.	11	50	43	30.030	. . .	W.
12	55	49	29.650	.225	W.	12	64	48	29.530	.006	S. E.	12	58	45	29.763	. . .	E.
13	56	43	29.997	.160	N. N. E.	13	60	47	29.550	.100	S. E.	13	61	52	29.416	.090	N. E.
14	47	36	30.100	.040	N. E.	14	60	48	29.622	.100	S. W.	14	64	45	29.350	.100	S. W.
15	45	32	30.070	. . .	N. W.	15	59	45	29.753	.040	S. W.	15	63	43	29.391	. . .	N. W.
16	51	40	29.962	. . .	W.	16	64	49	29.400	.120	S. W.	16	65	45	29.430	.250	N. E.
17	54	42	29.669	.360	N. N. E.	17	66	50	29.730	.060	S. W.	17	65	47	29.536	.360	S.
18	48	36	29.950	.100	N. E.	18	67	49	29.800	.100	N. E.	18	60	45	29.800	.030	N. W.
19	57	39	29.621	.120	N. W.	19	60	48	29.550	.320	N. W.	19	64	43	29.936	. . .	N. E.
20	53	37	29.800	.040	W.	20	59	47	29.745	.100	W.	20	68	53	29.900	.015	W.
21	57	34	29.923	. . .	E.	21	58	47	30.050	. . .	N. W.	21	65	49	29.626	.120	S. W.
22	56	33	30.050	.050	W.	22	66	47	29.850	. . .	W.	22	63	45	29.500	.020	S. E.
23	56	34	29.963	.002	W.	23	66	45	29.750	. . .	S. W.	23	62	48	29.500	.070	S. W.
24	58	44	29.920	.015	S. E.	24	70	52	29.600	. . .		24	60	48	29.396	.120	S. W.
25	56	35	29.854	.120	W.	25	62	44	29.932	.100		25	70	50	29.550	.030	S. W.
26	58	40	29.550	.160	S. W.	26	63	50	30.000	. . .		26	66	50	29.880	. . .	S. W.
27	52	39	29.300	.210	S. W.	27	63	44	30.020	. . .		27	66	57	30.230	. . .	S. W.
28	57	41	29.442	.080	W.	28	65	48	29.750	. . .		28	74	56	30.344	. . .	N. W.
29	56	42	29.481	.310	W.	29	70	52	29.745	.020		29	75	55	30.358	. . .	E.
30	54	35	29.623	.050	S. W.	30	68	49	30.200	.100		30	78	51	30.350	. . .	E.
						31	65	54	30.462	. . .							

JANUARY.						FEBRUARY.						MARCH.					
	Thermom.		Barom.	Rain.	Wind.		Thermom.		Barom.	Rain.	Wind.		Thermom.		Barom.	Rain.	Wind.
	Max.	Min.					Max.	Min.					Max.	Min.			
1	46°	43°	30.338	.040	E. by N.	1	38°	28°	29.764	.050	N. W.	1	40°	30°	30.400	. . .	E.
2	44	38	30.019	. . .	E.	2	38	32	30.000	. . .	E.	2	43	39	30.550	. . .	N. E.
3	41	34	29.616	.010	S. E.	3	38	32	30.034	.020	E. N. E.	3	43	35	30.558	. . .	N. E.
4	41	35	29.441	. . .	E. N. E.	4	40	29	30.200	.010	W. N. W.	4	46	40	30.484	. . .	N. E.
5	47	38	29.626	.320	E. S. E.	5	44	34	30.148	.025	W.	5	44	39	30.412	. . .	N. E.
6	48	41	29.914	.700	E.	6	47	40	29.649	.060	W. N. W.	6	47	40	30 284	.002	N. E.
7	48	43	29.836	. . .	E.	7	50	32	29.468	.020	W.	7	44	35	30.168	. . .	N. E.
8	48	43	29.900	.020	E. by S.	8	33	22	29.550	.200	W.	8	46	36	30.250	. . .	N.
9	45	40	30.100	. . .	N. N. W.	9	33	22	29.540	.050	N. W.	9	47	35	30.134	. . .	N. W.
10	44	38	30.054	.006	S. E.	10	32	24	29.640	.015	N. W.	10	44	32	29.992	.030	N. E.
11	40	37	29.990	. . .	S. E.	11	34	20	29.779	. . .	N. W.	11	39	22	30.150	.020	W.
12	42	39	29.876	. . .	S. E.	12	33	19	29.800	. . .	N. W.	12	44	33	30.168	.020	N. W.
13	41	26	29.782	. . .	S. E.	13	28	11	29.900	. . .	N. W.	13	46	39	30.176	. . .	W.
14	46	27	29.800	.006	S. E.	14	48	19	29.500	.120	W.	14	50	33	30.050	. . .	E.
15	49	45	29.724	.010	S. E.	15	51	39	29.250	.200	S. W.	15	54	46	29.700	. . .	S. E.
16	48	30	29.924	.010	S. E.	16	52	37	29.572	.025	S. W.	16	56	47	29.482	.030	S. E.
17	43	34	30.020	.030	E.	17	51	39	29.572	.160	S. W.	17	54	47	29.450	.050	S. E.
18	42	36	30.000	. . .	S. E.	18	56	41	29.550	.008	S. W.	18	54	46	29.620	. . .	S. E.
19	42	35	30.050	.050	S. E.	19	51	34	29.834	.520	N. W.	19	56	44	29.350	.015	S. E.
20	39	36	29.890	.090	S. S. W.	20	46	38	29.920	.008	S. W.	20	52	43	29.140	.120	S. W.
21	44	39	29.570	.640	W.	21	51	39	30.100	. . .	S. E.	21	58	45	29.280	.020	S. E.
22	49	43	29.500	.030	S. S. W.	22	54	40	30.184	. . .	N. E.	22	52	33	29.740	.040	W.
23	49	42	29.416	.100	S. W.	23	53	42	30.092	. . .	N. E.	23	53	39	29.532	.060	W.
24	48	39	28.700	.300	W. S. W.	24	46	38	30.084	. . .	E.	24	49	37	29.740	.055	W.
25	48	37	28.884	.120	S. W.	25	44	32	30.060	. . .	E.	25	50	37	29.850	. . .	S. E.
26	48	37	29.114	.010	S. W.	26	44	29	30.032	. . .	E.	26	51	45	29.734	.020	S. E.
27	51	39	29.050	.080	W.	27	39	32	30.072	. . .	E.	27	57	42	29.826	. . .	S. E.
28	46	37	28.960	. . .	W.	28	40	33	30.250	.080	E.	28	51	44	29.640	.200	S. E.
29	46	35	29.238	. . .	W.							29	45	30	29.850	.100	N.
30	46	35	29.544	.026	W.							30	45	30	29.742	. . .	N. E.
31	44	28	29.750	. . .	N.							31	44	30	29.500	.200	N. E.

OCTOBER.							NOVEMBER.							DECEMBER.						
	Thermom.		Barom.	Rain.	Wind.			Thermom.		Barom.	Rain.	Wind.			Thermom.		Barom.	Rain.	Wind.	
	Max.	Min.						Max.	Min.						Max.	Min.				
1	59°	48°	30.144	. . .	E.		1	57°	51°	30.019	.100	W.		1	56°	38°	30.150	.100	N. W.	
2	56	48	30.150	. . .	E.		2	59	50	30.234	.045	N. N. W.		2	55	42	30.000	. . .	W.	
3	57	48	30.148	. . .	E.		3	54	46	30.270	. . .	W.		3	58	44	30.000	.050	W.	
4	55	48	30.036	. . .	W.		4	54	50	30.050	.006	E.		4	48	42	29.650	.006	W. S. W.	
5	54	46	29.778	.090	N.		5	57	49	29.740	. . .	S. E.		5	51	36	29.200	.160	S. W.	
6	50	45	29.524	.120	E.		6	58	51	29.742	.020	S.		6	51	36	28.320	.220	S. W.	
7	53	43	29.320	.150	S. W.		7	61	51	29.564	. . .	S. W.		7	48	39	29.100	.120	W. N. W.	
8	53	46	29.600	.002	S.		8	61	55	29.000	.240	S. E.		8	43	32	29.532	. . .	W.	
9	57	46	29.680	.060	E.		9	56	42	29.770	.260	W.		9	54	35	29.150	.120	W.	
10	59	47	29.500	.120	S.		10	59	39	29.950	. . .	S. W.		10	58	33	29.600	.060	E.	
11	63	54	29.600	.220	S. E.		11	55	45	30.000	.700	S. E.		11	47	32	29.560	.200	N. W.	
12	63	55	29.730	.322	S.		12	47	35	30.200	.320	W.		12	48	34	29.740	.068	S. W.	
13	60	54	29.900	.060	S. E.		13	52	39	30.140	.008	N. W.		13	46	35	29.716	.120	N. W.	
14	58	51	29.828	. . .	E.		14	57	47	30.140	.015	S. W.		14	53	43	29.696	. . .	S. E.	
15	54	49	29.824	. . .	N. E.		15	58	55	30.150	. . .	W.		15	53	43	29.582	.546	W.	
16	55	47	29.970	. . .	E.		16	59	41	30.239	.060	W. N. W.		16	52	43	29.372	.020	W.	
17	55	37	29.888	. . .	W.		17	47	36	30.350	. . .	N. W.		17	53	41	29.200	.220	S. W.	
18	59	45	29.563	. . .	S. W.		18	44	29	30.450	. . .	N. W.		18	51	43	29.280	.140	W.	
19	63	51	29.250	.060	S. W.		19	45	35	30.300	. . .	W.		19	44	27	29.224	. . .	E.	
20	59	40	29.558	.070	W.		20	51	33	30.100	. . .	N. W.		20	44	31	29.750	.208	N. E.	
21	57	41	29.700	. . .	W.		21	51	38	29.400	. . .	S. E.		21	43	33	29.578	. . .	N. E.	
22	50	44	29.850	. . .	W.		22	51	40	29.560	.100	N. W.		22	40	36	29.650	.080	E.	
23	57	45	29.529	.060	W.		23	57	39	29.500	.025	W.		23	41	37	29.672	. . .	S. E.	
24	52	40	29.630	.060	W.		24	50	39	29.700	.006	N. W.		24	42	39	29.900	.210	S. E.	
25	50	38	30.000	.020	N. N. W.		25	51	48	29.570	.100	S. W.		25	43	34	30.212	.025	E.	
26	56	46	30.100	.060	S. E.		26	57	38	29.691	.160	S. W.		26	43	40	30.250	. . .	E.	
27	60	52	30.100	.120	W.		27	46	39	29.240	. . .	E.		27	43	37	30.237	. . .	W.	
28	56	35	30.140	. . .	N. W.		28	41	30	28.950	.100	W.		28	44	38	30.150	.015	S.	
29	56	38	30.134	.008	W.		29	40	35	29.319	.025	W.		29	46	42	29.700	.120	S. E.	
30	55	41	30.150	. . .	S.		30	56	38	29.500	.025	S. W.		30	49	32	29.782	.160	N. W.	
31	56	49	30.000	.160	W.									31	40	24	29.920	. . .	N. W.	

				RAIN.	MEAN TEMP.
January	2.598	41.0	July	.800	64.7
February . . .	1.577	37.8	August	1.240	59.2
March	.982	43.0	September . . .	1.267	55.0
April	2.862	45.0	October	1.762	51.0
May	1.876	53.6	November . . .	2.315	51.3
June	1.395	57.1	December . . .	2.968	42.3
				21.652	

No. II.

ACCOUNT

OF THE

ROYAL IRISH ACADEMY,

FROM 1ST APRIL, 1847, TO 31ST MARCH, 1848.

THE CHARGE.

	£	s.	d.	£	s.	d.
To balance in favour of the Public on 31st March, 1847, ...	. .	. .		102	12	2
Parliamentary Grant for 1847 (paid 25th June, 1847), ...	300	0	0			
Quarterly Warrants from Treasury, . . .	146	17	8			
Total from Treasury, . . .				446	17	8
INTEREST ON STOCK:						
Half year's on £1643 19 6, 3¼ per Cent.	26	14	4			
Ditto, „ 867 1 10, 3 „ .	13	0	2			
Ditto, „ 1643 19 6, 3¼ „ .	26	14	3			
Ditto, „ 867 1 10, 3 „ .	13	0	2			
Total Interest on Stock, . . .				79	8	11
RENT OF STABLE, due 1st November, 1847, .	21	0	0			
Less Poor Rate, ...	0	13	1			
				20	6	11
PUBLICATIONS SOLD:						
Transactions and Proceedings, &c., sold here, ...	10	10	6			
Ditto, sold in London by Messrs. Boone,	17	6	0			
Total Amount of Books sold, .				27	16	6
LIFE COMPOSITIONS:						
Nathaniel Hone, Esq., ...	21	0	0			
Right Hon. Sir Thomas Esmonde, Bart., .	21	0	0			
Forward,	42	0	0	677	2	2

	£	s.	d.	£	s.	
Brought forward, ...	42	0	0	677	2	
G. J. Allman, M. D., ...	21	0	0			
Eaton Hodgkinson, Esq. (non-resident), .	15	15	0			
Leonard Dobbin, Esq., ...	21	0	0			
Charles Tarrant, Esq., ...	21	0	0			
Sir William Betham (having paid twenty annual subscriptions), ...	6	6	0			
Total Life Compositions, . .				127	1	
ENTRANCE FEES:						
Nathaniel Hone, Esq., ...	5	5	0			
Right Hon. Sir Thomas Esmonde, Bart., .	5	5	0			
J. W. M. Berry, Esq., ...	5	5	0			
P. Jones, Esq., ...	5	5	0			
R. V. Boyle, Esq., ...	5	5	0			
Edward Barnes, Esq., ...	5	5	0			
Henry Freke, Esq., ...	5	5	0			
A. W. Baker, Jun., Esq., ...	5	5	0			
J. C. Egan, M. D., ...	5	5	0			
A. S. Ormsby, Esq., ...	5	5	0			
J. O'Donovan, Esq., ...	5	5	0			
Eaton Hodgkinson, Esq., ...	5	5	0			
Henry Wilson, Esq., ...	5	5	0			
Henry Croly, M. D., ...	5	5	0			
John Grene, Esq., ...	5	5	0			
W. T. Lett, Esq., ...	5	5	0			
George Miller, Esq., ...	5	5	0			
A. H. Haliday, Esq., ...	5	5	0			
Charles Tarrant, Esq., ...	5	5	0			
F. V. Clarendon, Esq., ...	5	5	0			
M. E. Talbot, Esq., ...	5	5	0			
Rev. M. Newport, ...	5	5	0			
Rev. J. J. Taylor, ...	5	5	0			
C. S. Ottley, Esq., ...	5	5	0			
O'Neale Segrave, Esq., ...	5	5	0			
Total Entrance Fees, . . .				131	5	0
ANNUAL SUBSCRIPTIONS AND ARREARS:						
David Moore, Esq., ... 1847,	2	2	0			
W. Drennan, Esq., ... 1846,	2	2	0			
Ditto, ... 1847,	2	2	0			
Robert Franks, Esq., ... ,,	2	2	0			
Jacob Owen, Esq., ... ,,	2	2	0			
F. Churchill, M. D., ... ,,	2	2	0			
Acheson Lyle, Esq., ... ,,	2	2	0			
Forward,	14	14	0	935	8	2

		£	s.	d.	£	s.	d.
Brought forward,		14	14	0	935	8	2
Sir Philip Crampton, Bart.,	1846,	2	2	0			
Ditto,	1847,	2	2	0			
W. Hogan, A. M.,	„	2	2	0			
Hon. James King,	„	2	2	0			
C. T. Webber, Esq.,	„	2	2	0			
J. S. Close, Esq.,	„	2	2	0			
Hon. Justice Crampton,	„	2	2	0			
Edward Hutton, Esq.,	„	2	2	0			
Conyngham Ellis, Esq.,	„	2	2	0			
J. B. Kennedy, Esq.,	„	2	2	0			
James Magee, Esq.,	„	2	2	0			
M. M. O'Grady, M. D.,	„	2	2	0			
Alexander Ferrier, Esq.,	„	2	2	0			
W. T. Mulvany, Esq.,	„	2	2	0			
Sir M. Chapman, Bart.,	„	2	2	0			
W. T. Mac Cullagh, Esq.,	1846,	2	2	0			
Thomas Cather, Esq.,	1847,	2	2	0			
Sir Richard Morrison,	„	2	2	0			
G. A Hamilton, Esq., M. P.,	„	2	2	0			
John Alcorn, Esq.,	„	2	2	0			
W. M'Dougall, Esq.,	„	2	2	0			
B. J. Chapman, Esq.,	1846,	2	2	0			
John Hart, M. D.,	1847,	2	2	0			
G. J. Allman, M. D.,	„	2	2	0			
William Henn, Esq.,	„	2	2	0			
Rev. John Connell,	„	2	2	0			
Rev. Richard Butler,	„	2	2	0			
Charles Bournes, Esq.,	„	2	2	0			
Robert Tighe, Esq.,	„	2	2	0			
H. Clare, Esq.,	„	2	2	0			
His Grace the Archbishop of Dublin,	„	2	2	0			
John Hamilton, Esq.,	„	2	2	0			
James Jameson, Esq.,	„	2	2	0			
Rev. C. Porter,	„	2	2	0			
F. L'Estrange, Esq.,	„	2	2	0			
C. C. King, Esq.,	„	2	2	0			
George Lefroy, Esq.,	„	2	2	0			
Lord Farnham,	„	2	2	0			
John Davidson, Esq.,	„	2	2	0			
F. M. Jennings, Esq.,	„	2	2	0			
Rev. James Wills,	„	2	2	0			
N. P. O'Gorman, Esq.,	„	2	2	0			
C. W. Williams, Esq.,	1846,	2	2	0			
Ditto,	1847,	2	2	0			
Forward,		107	2	0	935	8	2

		£	s.	d.	£	s.	d.
Brought forward,		107	2	0	935	8	2
Sir John Kingston James, Bart.,	1847,	2	2	0			
H. W. Massy, Esq.,	,,	2	2	0			
A. W. Baker, Esq.,	,,	2	2	0			
Sir E. Burrough, Bart.,	,,	2	2	0			
William Edington, Esq.,	,,	2	2	0			
Dean of St. Patrick's,	,,	2	2	0			
John M'Mullen, Esq.,	,,	2	2	0			
Charles Doyne, Esq.,	,,	2	2	0			
James M'Donnell, Esq.,	,,	2	2	0			
James Talbot, Jun., Esq.,	,,	2	2	0			
James Apjohn, M. D.,	,,	2	2	0			
A. B. Cane, Esq.,	,,	2	2	0			
Richard Cane, Esq.,	,,	2	2	0			
F. W. Burton, Esq.,	,,	2	2	0			
Rev. John West,	,,	2	2	0			
Algernon Preston, Esq.,	,,	2	2	0			
Sir Lucius O'Brien, Bart.,	,,	2	2	0			
Pierce Morton, Esq.,	,,	2	2	0			
John Aldridge, M. D.,	,,	2	2	0			
Robert Adams, Esq.,	,,	2	2	0			
Rev. H. F. C. Logan,	,,	2	2	0			
R. W. Townsend, Esq.,	,,	2	2	0			
Hon. F. Ponsonby,	,,	2	2	0			
J. S. Cooper, Esq.,	,,	2	2	0			
William Lefanu, Esq.,	,,	2	2	0			
J. Huband Smith, Esq.,	,,	2	2	0			
M. O. R. Dease, Esq.,	,,	2	2	0			
Joliffe Tuffnell, Esq.,	,,	2	2	0			
R. Deasy, Esq.,	,,	2	2	0			
John Philips, Esq.,	,,	2	2	0			
Robert Cully, Esq.,	,,	2	2	0			
Earl of Dunraven,	1845,	2	2	0			
Ditto,	1846,	2	2	0			
Ditto,	1847,	2	2	0			
Rev. W. Lee,	,,	2	2	0			
Sir Matthew Barrington, Bart.,	,,	2	2	0			
Rev. James Reid,	,,	2	2	0			
William Murray, Esq.,	,,	2	2	0			
E. Davy, Esq.,	,,	2	2	0			
Digby P. Starkey, Esq.,	,,	2	2	0			
William Monsell, Esq., M. P.,	1846,	2	2	0			
John Finlay, Esq.,	1847,	2	2	0			
John Mollan, M. D.,	,,	2	2	0			
Earl of Enniskillen,	,,	2	2	0			
Forward,		199	10	0	935	8	2

		£	s.	d.	£	s.	d.
Brought forward,		199	10	0	935	8	2
C. W. Hamilton, Esq.,	1847,	2	2	0			
A. R. Nugent, Esq.,	„	2	2	0			
T. R. Redington, Esq.,	„	2	2	0			
Rev. R. J. M'Ghee,	„	2	2	0			
G. A. Fraser, Esq.,	„	2	2	0			
Right Hon. Lord Chancellor,	„	2	2	0			
F. Barker, M. D.,	„	2	2	0			
Thomas Oldham, Esq.,	„	2	2	0			
George Carr, Esq.,	„	2	2	0			
Rev. George Longfield,	„	2	2	0			
Robert Law, M. D.,	„	2	2	0			
William Longfield, Esq.,	„	2	2	0			
W. E. Hudson, Esq.,	„	2	2	0			
T. J. Beasly, Esq.,	„	2	2	0			
Rev. N. I. Halpin,	„	2	2	0			
P. J. Blake, Esq.,	„	2	2	0			
Jacob Owen, Esq.,	„	2	2	0			
H. G. Hughes, Esq.,	„	2	2	0			
Right Hon. Chief Baron,	1846,	2	2	0			
Ditto,	1847,	2	2	0			
M. Longfield, Esq.,	„	2	2	0			
J. S. Eiffe, Esq.,	„	2	2	0			
W. J. O'Driscoll, Esq.,	„	2	2	0			
E. J. Cooper, Esq.,	„	2	2	0			
E. Bewley, M. D.,	„	2	2	0			
W. C. Dobbs, Esq.,	„	2	2	0			
J. M. Neligan, M. D.,	„	2	2	0			
H. H. Joy, Esq.,	„	2	2	0			
Stephen O'Meagher, Esq.,	„	2	2	0			
Rev. Francis Crawford,	„	2	2	0			
A. E. Gayer, Esq.,	1846,	2	2	0			
Ditto,	1847,	2	2	0			
Edward Cane, Esq.,	1846,	2	2	0			
Ditto,	1847,	2	2	0			
Abraham Abell, Esq.,	1846,	2	2	0			
Ditto,	1847,	2	2	0			
Philip Reade, Esq.,	„	2	2	0			
W. B. Wallace, Esq.,	„	2	2	0			
W. A. Wallace, Esq.,	„	2	2	0			
M. H. Stapleton, M. B.,	„	2	2	0			
Durham Dunlop, Esq.,	„	2	2	0			
J. Osborne, M. D.,	„	2	2	0			
G. A. Kennedy, M. D.,	„	2	2	0			
Acheson Lyle, Esq.,	„	2	2	0			
Forward,		291	18	0	935	8	2

		£	s.	d.	£	s.	d.
rought forward,		291	18	0	935	8	2
Gerald bon, Esq.,	1847,	2	2	0			
M. R. Sa Esq.	”	2	2	0			
Thomas G), Esq.,	”	2	2	0			
W. R. Wi Esq.,	”	2	2	0			
Samson Ca , Esq.,	”	2	2	0			
J. F. Waller, Esq.,	”	2	2	0			
Robert Mallet,	,	2	2	0			
T. E. Beatty, M	,	2	2	0			
Adolphus Cooke,	46,	2	2	0			
Ditto,	47,	2	2	0			
Rev. Samuel Ha ton,	,	2	2	0			
Thomas Butler, E ,	,	2	2	0			
Rev. J. A. Galbraith,	,	2	2	0			
William Barker, M. D.,	,	2	2	0			
Arthur Jacob, M. D.,	,	2	2	0			
John Tyrrell, Esq.,	,	2	2	0			
Dominick J. Corrigan, M. D.,	48,	2	2	0			
James Claridge, Esq.,	47,	2	2	0			
Captain Henry James,	”	2	2	0			
Philip Bevan, M. D.,	”	2	2	0			
James Patten, M. D.,	”	2	2	0			
Rev. Edward Marks, D. D.,	”	2	2	0			
Rev. I. G. Abeltshauser,	”	2	2	0			
T. F. Kelly, LL. D.,	”	2	2	0			
Rev. J. H. Jellett,	”	2	2	0			
Rev. R. V. Dixon,	1846,	2	2	0			
Ditto,	1847,	2	2	0			
William Gregory, M. D.,	”	2	2	0			
Wrigley Grimshaw, M. D ,	”	2	2	0			
E. Getty, Esq.,	”	2	2	0			
R. C. Walker, Esq.,	”	2	2	0			
O. Sproule, Esq.,	”	2	2	0			
Sir Thomas Staples, Bart.,	”	2	2	0			
W. T. Kent, Esq.,	”	2	2	0			
William Andrews, Esq.,	”	2	2	0			
F. W. Conway, Esq.,	”	2	2	0			
Alexander Taylor, M. D.,	”	2	2	0			
William Stokes, M. D.,	”	2	2	0			
Benjamin Wilme, Esq.,	”	2	2	0			
H. C. Beauchamp, M. D.,	”	2	2	0			
N. P. O'Gorman, Esq.,	”	2	2	0			
William Monsell, Esq., M. P.,	”	2	2	0			
E. S. Clarke, M. D.,	”	2	2	0			
C. Bolton, Esq.,	”	2	2	0			
Forward,		384	6	0	935	8	2

		£	s.	d.	£	s.	d.
Brought forward, ...		384	6	0	935	8	2
Robert Reid, M. D., ...	1847,	2	2	0			
R. C. Williams, M. D., ...	,,	2	2	0			
William Blacker, Esq., ...	,,	2	2	0			
William Roberts, Esq., ...	,,	2	2	0			
M. D'Arcy, Esq., ...	1848,	2	2	0			
W. T. Lloyd, Esq., ...	1847,	2	2	0			
R. W. Smith, Esq., ...	,,	2	2	0			
John Anster, LL. D., ...	,,	2	2	0			
R. J. Graves, M. D., ...	,,	2	2	0			
B. J. Chapman, Esq., ...	,,	2	2	0			
Robert Tighe, Esq., ...	1848,	2	2	0			
John Wynne, Esq., ...	1847,	2	2	0			
J. C. Deane, Esq., ...	,,	2	2	0			
Lord Wallscourt, ...	,,	2	2	0			
John D'Alton, Esq., ...	1846,	2	2	0			
Ditto, ...	1847,	2	2	0			
Sir Robert Kane, M. D., ...	1847,	2	2	0			
Ditto, ...	1848,	2	2	0			
Richard Sharpe, Esq., ...	1847,	2	2	0			
W F Montgomery, M. D., ...	1846,	2	2	0			
Ditto, ...	1847,	2	2	0			
Very Rev. the Dean of Kildare, . .	,,	2	2	0			
Sir M. Chapman, Bart., ...	1848,	2	2	0			
John Toleken, M. D., ...	1847,	2	2	0			
Samuel Ferguson, Esq., ...	,,	2	2	0			
George Cash, Esq., ...	,,	2	2	0			
John Burrowes, Esq., ...	1848,	2	2	0			
Very Rev. the Dean of Clonmacnoise,	,,	2	2	0			
Marmion Savage, Esq., ...	1846,	2	2	0			
Ditto, ...	1847,	2	2	0			
J. C. Egan, Esq., ...	1848,	2	2	0			
M. Donovan, Esq., ...	,,	2	2	0			
A. S. Ormsby, Esq., ...	,,	2	2	0			
Ven. Archdeacon of Cashel, ...	,,	2	2	0			
H. Freke, M. D., ...	,,	2	2	0			
F. J. Sidney, Esq., ...	,,	2	2	0			
M. M. O'Grady. M. D., ...	,,	2	2	0			
William Drennan, Esq., ...	,,	2	2	0			
Conyngham Ellis, Esq., ...	,,	2	2	0			
W. R. Wilde, Esq., ...	,,	2	2	0			
A. B. Cane, Esq., ...	,,	2	2	0			
Edward Cane, Esq., ...	,,	2	2	0			
Richard Cane, Esq., ...	,,	2	2	0			
George Wilkinson, Esq., ...	,,	2	2	0			
Forward,		476	14	0	935	8	2

		£	s.	d.	£	s.	d.
Brought forward, ...		476	14	0	935	8	2
William Brooke, Esq., ...	1848,	2	2	0			
Gerald Fitzgibbon, Esq., ...	„	2	2	0			
Hon. Judge Crampton, ...	„	2	2	0			
R. V. Boyle, Esq., ...	„	2	2	0			
W. Edington, Esq., ...	„	2	2	0			
Hon. and Very Rev. the Dean of St. Patrick's, ...	„	2	2	0			
Sir Richard Morrison, ...	„	2	2	0			
Charles Doyne, Esq., ...	„	2	2	0			
F. W. Burton, Esq., ...	„	2	2	0			
Right Hon. Justice Perrin, . . .	„	2	2	0			
James Pim, Esq., ...	„	2	2	0			
Robert Franks, Esq., ...	„	2	2	0			
Total Amount of Annual Subscriptions, .					501	18	0
SUBSCRIPTIONS FOR THE PURCHASE OF THE "DOMNACH AIRGID:"							
Sir William Betham, ...		1	0	0			
Robert Ball, Esq., ...		3	3	0			
James Pim, Esq., ...		2	0	0			
George Petrie, Esq., ...		1	0	0			
N. Hone, Esq., ...		2	2	0			
William Henn, Esq., ...		2	0	0			
F. W. Conway, Esq., ...		5	0	0			
Joseph Napier, Esq., M. P., ...		1	0	0			
H. C. Beauchamp, M. D., ...		0	10	0			
Very Rev. the Dean of Clonmacnoise, . .		1	0	0			
Lord Adare, ...		5	0	0			
C. T. Webber, Esq., ...		0	10	0			
Henry Roe, Esq., ...		1	3	0			
Rev. J. H. Singer, D. D., ...		1	0	0			
J. S. Close, Esq., ...		1	0	0			
Rev. J. Kennedy Bailie, D. D., ...		2	2	0			
Rev. C. R. Elrington, D. D., ...		1	0	0			
T. F. Bergan, Esq.		1	0	0			
Total Amount of Subscriptions received for Domnach Airgid this year, . . .					31	7	0
SUBSCRIPTION LIST FOR THE EXCAVATION OF DOWTH TUMULUS:							
George Carr, Esq., ...		1	0	0			
Captain Larcom, R. E., ...		5	0	0			
W. R. Wilde, Esq., ...		1	0	0			
W. Sweetman, Esq., ...		1	0	0			
J. R. Corballis, Esq., ...		1	0	0			
Forward,		9	0	0	1468	13	2

	£	s.	d.	£	s.	d.
Brought forward, ...	9	0	0	1468	13	2
W. E. Hudson, Esq., ...	1	0	0			
Thomas Oldham, Esq., ...	0	10	0			
Rev. J. H. Todd, D. D., ...	5	0	0			
Thomas Hutton, Esq., ...	1	0	0			
James M'Cullagh, LL. D., ...	1	0	0			
Mr. Maguire, ...	1	0	0			
Sir M. Chapman, Bart., ...	1	0	0			
W. E. Bolton, Esq., ...	1	0	0			
Rev. Charles Graves, A. M., ...	2	0	0			
R. H. Frith, Esq., ...	1	0	0			
C. P. M'Donnell, Esq., ...	1	0	0			
W. R. Wilde, Esq. (second subscription),	1	0	0			
Ven. Archdeacon Strong, ...	1	0	0			
John Burrowes, Esq., ...	0	10	0			
Sir W. R. Hamilton, LL. D., ...	1	0	0			
Rev. Richard M'Donnell, D. D., ...	0	5	0			
Rev. H. Lloyd, D. D., ...	5	0	0			
Lieut. Col. Harry D. Jones, R. E., ...	1	0	0			
Rev. W. H. Drummond, D. D., ...	1	0	0			
Henry Roe, Esq., ...	1	0	0			
Nathaniel Hone, Esq., ...	0	10	0			
F. W. Burton, Esq., ...	1	0	0			
Robert Ball, Esq., ...	3	0	0			
A. B. Cane, Esq., ...	0	10	0			
C. T. Webber, Esq., ...	0	5	0			
Richard Griffith, Esq., ...	1	0	0			
Total Amount of Subscriptions for Excavations at Dowth, up to this date, . .				42	10	0
TOTAL AMOUNT OF CHARGE, . . .	. . . .			1511	3	2

THE DISCHARGE.

Antiquities Purchased.	£	s.	d.	£	s.	
Carlton, P., ancient harp, ...	6	0	0			
Corry, John, antiquities, ...	2	15	0			
Curtis, W. H., sundry antiquities, ...	2	2	0			
Daly, M., celt and bronze vessel, ...	1	12	6			
Donegan, John, silver ornaments, &c., . .	32	5	0			
Farran, W., pot, ...	0	5	0			
Glennon, Richard, sundries, ...	0	11	0			
Kirwan, Bernard, silver antique, ...	2	5	0			
Maly, Michael, silver ornament, ...	0	7	6			
Nicholson, W., spear, ...	0	5	0			
O'Hara, J. P., copper vessel, ...	1	10	0			
Reade, Thomas, and Co., sword, ...	1	0	0			
Rowe, M. W., gold bulla, ...	0	10	6			
Smith, A., torquis, ...	2	0	0			
Thompson, W., sword, ...	1	0	0			
Toole, James, horse-bits and spurs, . . .	0	10	0			
Underwood, J., sundry antiquities, . . .	10	7	0			
Total Amount of Antiquities, . .				65	5	

Books, Printing, and Stationery.	£	s.	d.	£	s.	
Barthes and Lowell, books, ...	23	14	0			
Bavier, W., books, ...	1	10	0			
Bellew, Gerald, account books, ...	0	9	1			
Boone, T. and W., book, ...	1	1	0			
Carter, W., pencils, ...	0	6	0			
Cranfield, Thomas, printing, &c., ...	2	12	3			
Curry, Eugene, transcribing O'Neill's MS.,.	10	0	0			
Du Noyer, G., drawings, ...	2	17	6			
Dwyer, James, steel pens, ...	0	3	0			
Groves, E., books, ...	1	0	0			
Gill, M. H., balance of account for printing,	263	9	11			
Ditto, on account of printing Proceedings,	100	0	0			
Grant and Bolton, stamps, ...	0	10	0			
Hanlon, George, wood-cuts, ...	20	12	6			
Hodges and Smith, books, ...	50	16	0			
Forward,	479	1	3	65	5	

	£	s.	d.	£	s.	d.
Brought forward, ...	479	1	3	65	5	6
Jones, J., books, ...	5	0	0			
Johnston and Co., advertising Transactions, &c.	22	6	0			
Kirkwood, J., engravings, &c., ...	19	8	6			
Marshall, A., Books, ...	0	10	6			
M'Dowell, George, engravings, ...	14	12	0			
Millard, Thomas, wood-cuts, ...	2	2	6			
Mullen, George, binding, ...	6	13	4			
Nutt, David, books, ...	19	10	0			
O'Shaughnessy, J. J., printing sundries, .	8	5	3			
Perry, J. and H., ...	0	17	6			
Plunket, James, drawing catalogue, . . .	6	18	6			
Peterkin, James, engraving, ...	17	7	6			
Ray Society, subscription, 1846, 1847, . .	2	2	0			
Tallon, J., stationery, ...	3	8	4			
Taylor, E. and J., Memoirs, Part 17, . . .	2	14	0			
Wiseheart, ink, ...	0	0	6			
Total Amount of Books, Printing, &c., .				610	17	8
COALS, GAS, ETC.						
Consumers' Gas Company, gas, ...	16	17	7			
Do. coke, ...	1	14	0			
Edmundson, J., and Co., ...	0	1	2			
Hoey, James, one ton coal and carriage, . .	0	19	0			
Lang and Co., eleven tons coal, and carriage,	10	9	0			
Keenan, James, bogwood, ...	0	17	0			
Tharell, P., tapers, ...	0	2	0			
Total Amount of Coals, Gas, &c., . .				30	19	9
REPAIRS OF HOUSE.						
Browne, J., cleaning windows and glass, . .	3	3	0			
Malone, P., cleaning carpets, ...	0	5	0			
Murphy, James, sweeping chimneys, . . .	1	8	0			
Edmundson, J., and Co., sundries, ...	1	5	10			
Surman, George, sundry repairs, ...	16	5	6			
Total Repairs of House, ...				22	7	4
RENT, TAXES, AND INSURANCE.						
Symes, Arthur, one year's rent, ...	104	9	0			
Pipe water tax, ...	1	19	2			
Forward,	106	8	2	729	10	3

	£	s.	d.	£	s.	d.
Brought forward, ...	106	8	2	729	10	3
Minister's money, ...	2	15	5			
National Insurance Company, ...	9	16	0			
Globe do.	5	13	6			
Total Rent, Taxes, and Insurance, . .				124	13	1
FURNITURE AND REPAIRS.						
Daniel, P., taper stand, ...	0	0	10			
Groves, E., drawing of exterior of Christ Church, ...	2	0	0			
Hoy, C., cocoa matting, ...	0	14	2			
Surman, G., sundry repairs, ...	24	4	0			
Whitehead, J., frame, ...	0	5	0			
Total Amount of Furniture and Repairs,				27	4	0
SALARIES, WAGES, &c.						
Ball, Robert, Esq., Treasurer, ...	21	0	0			
Clibborn, Edward, ...	150	0	0			
Curry, Antony, attending meetings, . . .	1	7	6			
Drummond, Rev. W. H., D. D., Librarian, .	21	0	0			
Graves, Rev. Charles, A. M., Secretary of Council, ...	21	0	0			
Hamilton, William, hall porter, 13th March, 1847, to 25th March, 1848, ...	35	11	0			
Ditto, and wife, Christmas allowance, . .	2	2	0			
Lockett, J., livery for hall porter, ...	10	1	6			
O'Brien, T., messenger, 27th March, 1847, to 18th March, 1848, ...	38	5	0			
Plunkett, James, attending 13 meetings, . .	1	12	6			
Todd, Rev. J. H., D. D., Secretary to Academy, ...	21	0	0			
Todhunter, Isaac, Accountant, 27th March, 1847, to 18th March, 1848, ...	51	0	0			
Woodhouse, J., livery buttons, ...	0	17	0			
Wright and Co., hat for hall porter, . . .	0	15	0			
Total Salaries, Wages, &c., . .				375	11	6
CONTINGENCIES.						
Allen, William, gallic acid, &c., ...	0	1	1			
Bank of Ireland, for stamp on Treasury Warrant, ...	0	5	0			
Forward,	0	6	1	1256	18	10

	£	s.	d.	£	s.	d.
Brought forward, ...	0	6	1	1256	18	10
Barratt, Samuel, nails, ...	0	0	6			
Boone, T. F. W., sundry charges, ...	5	4	0			
Boyle, Low, Pim, and Co., sundries, . . .	0	7	2			
Box, W. R., gutta percha, ...	0	0	10			
Clibborn, Edward, one year's allowance for incidentals, ...	10	0	0			
Daniel, P., copper nails, ...	0	1	0			
Edmundson, J. and Co., locks, &c., . . .	0	4	9			
Gerty, E., coaches to Lord Lieutenant with Address, ...	1	19	0			
Johnston and Co., ...	0	4	10			
Salmon and Co., plaster of Paris, ...	0	1	5			
Surman, George, boxes, &c., ...	6	16	0			
Tighe, James, engrossing Address to Lord Lieutenant, ...	1	1	0			
Yates, G., tin case for drawings, ...	0	4	6			
Sharp, R., winding clocks, one year, . . .	0	15	0			
Serving notices of Professor M'Cullagh's funeral, ...	0	8	2			
Wallace, W. B. and Co., law costs, . . .	17	17	5			
Freight of parcels for one year, ...	4	14	5			
Postage sheets, and sundry postages for one year, ...	5	10	2			
Total Contingencies, . .				55	16	3
DOMNACH AIRGID, PURCHASE OF.						
Paid the Executors of the late James M'Cullagh, LL.D., balance of purchase-money, ...				100	0	0
EXCAVATION OF DOWTH TUMULUS.						
Paid on account of expenses of works at the Dowth Tumulus, ...				53	0	0
Total Discharge, ...				£1465	15	1
Balance in favour of the Public, ...				45	8	1
Total amount of Charge, ...				£1511	3	2

STATE OF THE BALANCE.

	£	s.	d.
In Bank of Ireland, ...	21	19	8
In Treasurer's hands, as per Account, ...	23	8	5
	£45	8	1

The Treasurer reports, that there is to the credit of the Academy in the Bank of Ireland, £867 1*s.* 10*d.* in Three per Cent. Consols, and £1643 19*s.* 6*d.* in Three and a quarter per Cent. Government Stock, the latter known as the Cunningham Fund.

(Signed), ROBERT BALL,
Treasurer.

31*st March*, 1848.

No. III.

METEOROLOGICAL JOURNAL,

COMMENCING

1st JANUARY, 1848, AND ENDING 31st DECEMBER, 1848,

BY

GEORGE YEATES.

The instruments employed, and the general circumstances of the mode of observing, have been described in the preliminary observations to the Tables of the year 1843, in the 2nd volume of the Proceedings of the Academy, Appendix V.

JANUARY.						FEBRUARY.						MARCH.					
	Thermom.		Barom.	Rain.	Wind.		Thermom.		Barom.	Rain.	Wind.		Thermom.		Barom.	Rain.	Wind.
	Max.	Min.					Max.	Min.					Max.	Min.			
1	39°	22°	29.600	.060	N.W.	1	34°	22°	29.850	. . .	N. W.	1	45°	37°	28.720	.080	S.
2	46	28	29.422	.020	N. E.	2	39	29	30.122	. . .	W.	2	43	34	29.350	.060	N. W.
3	53	44	29.343	.420	S. W.	3	46	37	30.834	. . .	S. W.	3	48	32	30.072	. . .	N. W.
4	54	37	29.680	.100	N. E.	4	53	45	29.846	.035	S. W.	4	45	31	29.963	. . .	S.
5	48	35	29.442	.060	W.	5	58	53	29.900	.068	S. W.	5	52	37	29.783	.140	N. W.
6	41	31	29.770	.035	W.	6	56	52	30.066	.120	S. W.	6	43	29	29.876	. . .	E.
7	44	32	29.480	.040	W.	7	56	50	29.880	.002	S. W.	7	45	39	29.850	.730	W.
8	40	35	29.600	.002	W.	8	54	43	29.670	.025	S. W.	8	49	39	30.000	.020	W.
9	44	36	30.064	.060	E.	9	53	42	28.820	.320	S. W.	9	53	45	29.783	. . .	W.
10	38	28	30.150	. . .	E.	10	48	36	28.708	.120	W.	10	58	39	29.320	.060	N. W.
11	41	30	30.450	.070	N. W.	11	45	36	29.200	.200	N.	11	47	35	28.812	.340	N. W.
12	41	34	30.500	. . .	N. W.	12	48	34	29.658	. . .	W.	12	44	36	28.900	.268	N. E.
13	46	40	30.271	.002	N. W.	13	54	42	29.600	. . .	S. W.	13	46	32	29.440	. . .	N. W.
14	45	39	30.089	.002	N. W.	14	55	44	29.634	.120	S. W.	14	48	31	29.748	. . .	S. W.
15	44	31	30.089	.002	W.	15	50	37	29.450	.220	N. W.	15	47	36	29.679	.060	N. W.
16	41	32	29.871	.016	W.	16	44	27	29.824	. . .	N. W.	16	50	37	29.580	.012	E.
17	43	30	29.360	.226	N. W.	17	38	26	30.340	. . .	N.	17	47	39	29.580	.028	N. E.
18	36	25	29.300	.006	W.	18	46	29	30.128	.002	N. W.	18	43	36	29.512	.030	E.
19	41	31	29.584	.298	E.	19	46	39	29.660	.106	W.	19	45	33	28.850	.060	W.
20	41	27	29.916	.090	W.	20	49	35	29.608	.430	N.	20	45	30	28.780	.025	W.
21	37	23	30.166	.003	S. E.	21	45	35	29.632	.046	W.	21	44	30	28.989	.002	N. W.
22	38	29	29.958	. . .	S. E.	22	52	39	29.044	.198	W.	22	46	31	29.350	.016	E.
23	38	34	30.210	.060	N. E.	23	52	40	29.000	.140	S. W.	23	53	44	29.450	.150	N. W.
24	30	26	30.450	.036	W.	24	50	42	28.944	.156	S. W.	24	54	43	30.064	. . .	W.
25	37	28	30.450	. . .	N. E	25	53	46	28.714	.050	S. W.	25	55	45	30.064	. . .	S.
26	35	32	30.100	. . .	N. E.	26	53	42	28.688	.146	N. E.	26	56	35	29.730	.080	W.
27	37	32	30.000	. . .	N. E.	27	55	37	28.308	.040	N. W.	27	51	31	29.650	. . .	E.
28	36	26	29.800	. . .	E. S. E.	28	54	43	28.980	.120	W.	28	50	40	29.560	.100	S. W.
29	34	21	29.652	. . .	E. S. E.	29	48	35	29.132	.080	W.	29	45	30	29.742	.120	N. W.
30	41	21	29.271	.280	N. E.							30	53	41	29.542	.008	S. W.
31	34	26	29.274	.120	N. W.							31	55	35	29.950	. . .	N. W.

APRIL.						MAY.						JUNE.					
	Thermom.		Barom.	Rain.	Wind.		Thermom.		Barom.	Rain.	Wind.		Thermom.		Barom.	Rain.	Wind.
	Max.	Min.					Max.	Min.					Max.	Min.			
1	53°	32°	30.008	. . .	S. E.	1	56°	35°	30.042	. . .	S. E.	1	61°	44°	29.772	.150	W.
2	58	36	29.863	. . .	E.	2	58	42	29.980	.006	S. E.	2	57	45	29.280	.120	S. W.
3	58	43	29.970	.480	W.	3	64	41	29.881	. . .	S. W.	3	64	43	29.250	.520	W.
4	64	44	30.100	. . .	N. W.	4	66	46	30.070	. . .	S. W.	4	64	45	29.374	.020	E.
5	59	48	29.950	. . .	N. W.	5	65	42	30.020	. . .	S. W.	5	63	47	29.510	. . .	W.
6	53	34	29.753	.100	N. W.	6	63	41	30.136	. . .	N. W.	6	62	45	29.680	.006	N. W.
7	48	31	29.648	.022	N.	7	65	46	29.916	. . .	W.	7	61	47	29.650	.006	S. W.
8	47	35	29.500	.030	N.	8	58	46	29.960	. . .	W.	8	64	43	29.674	. . .	W.
9	47	36	29.723	.068	N. E.	9	60	38	30.150	. . .	E.	9	64	48	29.622	. . .	W.
10	48	34	29.220	.060	W.	10	64	41	30.242	.060	E.	10	64	46	29.590	.160	W.
11	47	32	29.622	.038	S. E.	11	69	44	30.234	. . .	S. E.	11	66	48	29.740	.018	S. E.
12	48	39	29.382	.546	E.	12	75	56	30.162	. . .	W.	12	59	40	29.732	.500	S. E.
13	50	37	29.671	.320	E.	13	77	47	30.160	. . .	E.	13	65	45	29.500	.310	S. W.
14	49	30	29.923	. . .	N. W.	14	76	52	30.239	. . .	S. E.	14	53	45	29.650	.260	W.
15	51	39	29.680	.060	S. E.	15	74	43	29.839	. . .	S. W.	15	64	53	29.740	.100	S. E.
16	54	42	29.620	.048	S. E.	16	74	55	29.562	. . .	S. W.	16	69	51	29.850	.108	E.
17	55	42	29.400	.050	S.W.	17	66	47	29.320	. . .	E.	17	70	55	29.846	.010	N. W.
18	57	43	29.271	.220	E.	18	60	41	29.300	.330	W.	18	62	55	29.900	.160	E.
19	54	44	29.032	.380	E.	19	61	45	29.380	.010	E.	19	70	57	30.190	. . .	W.
20	56	45	29.400	.130	E.	20	63	43	30.000	. . .	W.	20	71	47	30.154	. . .	E.
21	58	41	29.612	. . .	N.	21	63	50	30.160	.075	N. W.	21	74	55	30.068	. . .	E.
22	60	44	29.723	.200	N. W.	22	69	55	30.350	. . .	W.	22	73	50	29.980	. . .	E.
23	56	45	29.782	.140	N. E.	23	75	48	30.349	. . .	E.	23	68	55	29.700	. . .	E.
24	48	43	29.871	.180	N. E.	24	76	51	30.300	. . .	N. W.	24	63	54	29.450	.770	E.
25	52	39	29.950	. . .	N.	25	75	49	30.289	. . .	E.	25	66	55	29.759	.080	E.
26	53	34	29.962	. . .	N. E.	26	69	46	30.102	. . .	E.	26	71	57	29.940	.008	E.
27	50	31	29.808	. . .	N. N. W.	27	75	51	30.072	. . .	N.	27	68	55	29.674	.245	W.
28	52	36	29.700	. . .	N. W.	28	73	53	30.072	. . .	N. E.	28	69	54	29.683	.045	W.
29	47	31	29.918	.020	N. N. W.	29	67	49	29.962	.080	W.	29	68	53	29.550	.050	W.
30	53	33	30.042	. . .	S. E.	30	66	41	30.168	.010	N. W.	30	65	50	29.540	.020	W.
						31	61	51	29.800	.140	W.						

JULY.						AUGUST.						SEPTEMBER.					
	Thermom.		Barom.	Rain.	Wind.		Thermom.		Barom.	Rain.	Wind.		Thermom.		Barom.	Rain.	Wind.
	Max.	Min.					Max.	Min.					Max.	Min.			
1	62°	47°	29.740	.090	N. W.	1	70°	52°	29.350	.962	W.	1	63°	41°	30.260	. . .	W.
2	61	45	29.742	.009	W.	2	65	47	29.800	.280	W.	2	69	54	30.400	. . .	W.
3	64	50	29.700	.120	E.	3	66	46	29.760	.100	W.	3	66	47	30.364	. . .	S. W.
4	64	49	29.991	.020	S. E.	4	61	41	29.622	.100	W.	4	68	40	30.086	. . .	S.
5	66	46	30.039	. . .	S. E.	5	64	45	29.422	. . .	E.	5	70	55	29.650	. . .	S. E.
6	71	58	29.950	.030	W.	6	65	50	29.564	.420	W.	6	67	57	29.724	.220	W.
7	76	59	29.643	. . .	W.	7	63	44	29.813	.527	W.	7	62	55	29.880	.002	W.
8	72	53	29.750	.220	W.	8	65	49	29.790	.100	S.	8	65	52	29.750	.030	W.
9	67	50	29.671	.480	E.	9	60	45	29.732	.200	N. W.	9	61	48	29.780	.006	W.
10	69	49	30.200	.040	W.	10	65	46	29.950	.020	W.	10	66	47	29.678	1.220	N. E.
11	72	51	30.413	. . .	W.	11	67	47	30.012	.002	E.	11	51	38	30.134	. . .	N. W.
12	74	53	30.461	. . .	E.	12	62	39	30.048	. . .	W.	12	55	45	30.300	. . .	W.
13	78	54	30.461	. . .	S.	13	66	50	30.000	. . .	N. E.	13	55	45	30.280	. . .	W.
14	81	61	30.400	. . .	S. E.	14	70	54	29.863	.100	N. E.	14	59	49	30.280	. . .	W.
15	75	50	30.332	. . .	N.	15	55	51	29.828	.200	N. E.	15	63	53	30.289	. . .	N.
16	71	55	30.330	. . .	N.	16	59	53	29.818	.200	S. E.	16	65	55	30.300	. . .	S. W.
17	77	52	30.274	. . .	N. W.	17	66	52	29.650	.240	W.	17	66	50	30.280	. . .	N. W.
18	65	54	30.090	. . .	N. E.	18	66	44	29.950	. . .	E.	18	63	42	30.300	. . .	E.
19	67	56	29.433	.090	W.	19	63	51	29.584	.425	S. W.	19	60	42	29.761	. . .	S. W.
20	72	55	29.050	.400	W.	20	65	48	29.840	.004	S. W.	20	69	42	29.568	.250	N. W.
21	66	57	29.521	.040	W.	21	65	50	29.064	.250	N. E.	21	59	42	29.750	. . .	S. E.
22	67	62	29.600	.040	W.	22	59	45	29.492	.150	W.	22	61	47	29.730	. . .	E.
23	65	48	29.741	.110	W.	23	59	48	29.650	.010	N. W.	23	62	54	29.599	.002	S. E.
24	70	47	29.750	.220	W.	24	61	46	29.910	.025	N. W.	24	67	53	29.290	.200	S. E.
25	68	56	29.500	.090	W.	25	61	50	29.950	.006	S. E.	25	62	50	29.412	.050	S. E.
26	65	52	29.583	. . .	W.	26	69	55	29.636	.025	S. W.	26	58	54	29.600	. . .	E.
27	67	52	29.620	. . .	W.	27	74	54	29.724	.030	S. W.	27	58	51	29.828	.420	N. E.
28	69	50	29.963	.010	W.	28	67	52	29.650	. . .	S. W.	28	60	53	29.960	. . .	N. E.
29	70	54	30.018	.100	S. W.	29	67	52	29.850	.006	W.	29	57	52	29.884	.010	N. E.
30	72	57	29.580	.060	W.	30	64	49	30.060	.060	N.	30	55	48	29.750	.110	N. W.
31	69	51	29.500	. . .	W.	31	63	46	30.151	. . .	W.						

OCTOBER.						NOVEMBER.						DECEMBER.					
	Thermom.		Barom.	Rain.	Wind.		Thermom.		Barom.	Rain.	Wind.		Thermom.		Barom.	Rain.	Wind.
	Max.	Min.					Max.	Min.					Max.	Min.			
1	55°	47°	29.540	.140	S. W.	1	50°	33°	29.650	.008	N.	1	43°	36°	29.500	.045	W.
2	57	52	29.400	.070	S.	2	46	35	29.826	.090	W.	2	45	35	29.182	.260	S. W.
3	56	44	29.474	.100	S. E.	3	48	40	29.500	.040	N. W.	3	42	32	29.580	.120	S. W.
4	63	52	29.400	.080	N. W.	4	43	29	29.808	.072	W.	4	53	39	29.850	.200	S. W.
5	64	58	29.782	. . .	S. W.	5	46	30	29.700	.002	N. W.	5	43	34	29.050	.250	S. W.
6	70	58	30.000	. . .	W.	6	48	45	29.680	. . .	N. W.	6	45	38	29.000	.038	S. W.
7	65	54	30.008	. . .	W.	7	49	34	29.716	.008	W.	7	43	38	29.328	.260	S. W.
8	66	53	29.944	. . .	W.	8	46	32	30.184	. . .	N. W.	8	52	38	29.522	.040	S. W.
9	60	50	29.812	.030	W.	9	43	34	30.376	.020	N. W.	9	57	47	29.750	.060	S. W.
10	58	48	29.814	.150	N. W.	10	43	28	30.450	.036	W.	10	58	54	29.950	.010	S. W.
11	58	40	30.000	. . .	S. W.	11	44	28	30.522	.008	N. W.	11	63	49	29.948	. . .	W.
12	56	42	30.020	.008	S. E.	12	46	41	30.584	.018	N. E.	12	53	32	29.990	. . .	S. E.
13	55	45	30.236	.180	S. E.	13	56	29	30.500	.002	N. W.	13	58	51	29.622	.040	S. W.
14	53	45	30.262	.190	N. E.	14	44	34	30.460	. . .	N. W.	14	55	48	29.350	.040	S. E.
15	50	42	30.100	.220	N. E.	15	49	37	30.528	. . .	N. W.	15	53	43	29.044	.380	S. E.
16	52	47	29.946	.460	N. E.	16	46	39	30.280	. . .	N. E.	16	54	38	29.774	.100	W.
17	52	42	30.100	.180	N. E.	17	56	42	30.000	.035	W.	17	43	35	29.730	. . .	S. E.
18	46	31	29.900	.002	N. W.	18	54	44	29.642	.010	S. W.	18	49	42	29.500	.060	S. E.
19	39	33	29.930	.160	N. E.	19	53	34	29.950	.100	S. W.	19	50	31	29.922	.030	N. W.
20	44	31	30.824	.029	N. W.	20	60	42	29.440	. . .	W.	20	43	25	30.150	. . .	N.
21	44	28	29.884	.120	N.	21	54	40	29.500	.180	S. W.	21	43	28	30.250	. . .	S. E.
22	47	34	29.368	.180	S.	22	48	42	28.973	.090	S. W.	22	38	28	30.300	.076	S. E.
23	49	35	29.388	.150	W.	23	50	40	29.000	.350	N. W.	23	39	28	30.312	. . .	S. E.
24	50	39	29.250	.110	W.	24	45	33	29.820	.010	N. W.	24	38	33	29.820	. . .	S. E.
25	54	41	29.376	.010	N. W.	25	47	33	29.700	. . .	S. E.	25	47	37	29.650	.050	S. E.
26	50	38	29.680	. . .	W.	26	55	45	29.700	. . .	N. W.	26	53	44	29.450	.260	N. W.
27	53	48	29.350	. . .	S.	27	50	43	29.874	. . .	W.	27	53	39	30.050	.250	N. W.
28	55	41	29.998	.100	S. W.	28	49	44	29.882	. . .	S. W.	28	43	26	30.150	. . .	N. W.
29	49	39	29.330	.006	S.	29	57	48	29.816	. . .	W.	29	43	27	30.100	.068	S. E.
30	53	42	29.360	.150	N. E.	30	51	38	29.900	.400	W.	30	44	42	30.088	.930	S. E.
31	46	35	29.544	.480	W.							31	43	38	30.100	. . .	S. E.

	RAIN.	MEAN TEMP.		RAIN.	MEAN TEMP.
January	2.008	35.6	July	2.169	60.8
February . . .	2.744	43.9	August	4.443	51.3
March	2.389	42.2	September. . .	2.520	55.3
April	2.992	45.4	October	3.305	46.9
May	.711	56.7	November . . .	1.477	58.2
June	3.660	55.0	December . . .	2.667	42.6
				31.085	

No. IV.

CATALOGUE

OF THE

TRADESMEN'S TOKENS,

CURRENT IN IRELAND BETWEEN THE YEARS 1637 AND 1679.

BY

AQUILLA SMITH, M. D., M. R. I. A.

◆

ABBEY BOYLE, *see* BOYLE.

ANTRIM, CO. ANTRIM.

1.	BRYCE . CRAFORD .	ANTRVM . MARCH^{T}	1657
2.	GILBERT . ROSS .	IN . ANTRIM .	
3.	IOH . VAVCH . MARCH^{T}	IN . ANTRIM.	
4.	IOHN . STEWARD . OF .	ANTRIM . MARCHAN^{T}	
5.	IOHN . WHITE . OF .	ANTRIM . MARCHAN^{T}	
6.	MATTHEW . BETHELL .	POST . M^{S}TR . IN . ANTRIM .	1671
7.	ROBART . YOVNG .	DYER . IN . ANTRIM .	
8.	SAMVEL . SHENNAN .	IN . ANTRM . MARCH^{T}	—68
9.	THOMAS . PALMER . IN .	ANTRIM . MARCHANT .	
10.	WILL . STEWART . IN .	ANTRVM . MARCHAN^{T}	1656
11.	WILLIAM . CRAFORD .	IN . ANTRVM . MERCHANT .	1656

ARDEE, CO. LOUTH.

12.	IAMES . ATKINSON . OF .	ARTERDE . MARCHANT . HIS . I^{D}	
13.	IOHN . ALLEN . OF . ARTHERDEE .	HIS . PENNY .	1670
14.	THO . ROBEREY .	MERCHANT . OF . ARDEE .	1670

ARKLOW, CO. WICKLOW.

15.	SYMON . SHEEHAN .	OF . ARKLO . MARCHA .	

ARMAGH, CO. ARMAGH.

16.	IAMES . TAYLOR . MARCH .	IN . ARDEMACH .	1664
17.	IOHN . DAVISON . OF .	ARDMACH .	1671
18.	IOHN . DAVISON . OF .	ARDMAGH .	1671
19.	IOHN . HOLMES .	OF . ARDMAGH .	
20.	IOHN . SINKLER . OF .	ARDMAGH . MERCHANT .	
21.	THOMAS . SANDERS .	OF . ARDMAGH . MAR .	

ARTHERDEE, *see* ARDEE.

ATHBOY, CO. MEATH.

22.	IOHN . RIGGS . MARC .	IN . ATHBOY .	

ATHENRY, CO. GALWAY.

23.	THOMAS . CLOAN . OF .	ATHENRY . MERCHANT .	

ATHLONE, CO. ROSCOMMON.

24.	ALDRIGE . SADLER .	OF . ATHLONE . BAKER .	
25.	GEORGE . MILLS . OF .	ATHLONE . MARCHAN .	
26.	HUGH . COFFY . IN .	ATHLONE . MARCHANT .	
27.	IOHN . S**TTER* .	OF . ATHLONE .	1655
28.	MARTYN . MURPHY .	IN . ATHLONE . MARCHAN .	
29.	NICHOLAS . MALONE .	ATHLONE . MARCHANT .	
30.	RICHARD . KELLY . OF .	ATHLONE . MERCH .	
31.	RICHARD . KELLY . OF .	ATHLOONE . MERCH .	
32.	STEPHEN . SMITH . OF .	ATHLONE . SHOOMAKER .	
33.	WALTER . KELLY .	OF . ATHLONE .	
34.	WILL . ANTREBUS .	IN . ARTHLON .	
35.	WILL . ANTRIBUS .	** . ARTHLON .	
36.	WILLIAM . FALLON .	OF . ATHLONE .	
37.	WILLIAM . HILL . OF .	ATHLON . MARCHANT .	1656
38.	WILLIAM . IDATE .	** . ATHLONE .	
39.	WILLIAM . MORHEAD .	OF . ATHLON . MARCH .	

ATHY, CO. KILDARE.

40.	WILLAM . ADDIS .	OF . ATHY .	1659

AUGHER, CO. TYRONE.

41.	IAMES . MORIE .	' IN . AVGHOR . MARCH^{T}	

BALLINAKILL, QUEEN'S CO.

42.	NIC . DANELL . OF .	BALLNAKILL .	

BALLYBOY, KING'S CO.

43.	ROB . HVTCHINSON .	OF . BALLYBOY . MARCH .	1668
44.	THO . MAIRE . OF .	BALLYBOY . TANNER .	

BALLYMENA, *see* BELLEMANOGH.

BALLYMORE, CO. WESTMEATH.

45.	EDMOND . PETTIT . OF .	BALLYMORE . MARC .	
46.	LVKE . TYRRELL . OF .	BALLIMORE . MERC^{T}	

BALTIMORE, CO. CORK.

47.	WILLIAM . PRIGG .	OF . BALTEMORE .	

BANDON, CO. CORK.

48.	BANDONE . ARMES .	CORPERASION .	1670

BANGOR, CO. DOWN.

49.	IAMES . CLEALAND .	OF . BANGOR .	
50.	IAMES . MOOR .	OF . BANGOR .	1657

BELFAST, CO. ANTRIM.

51.	BELFAST .	*A Ship.*	1671
52.	ALEXANDER . SINKLAR .	IN . BELFAST .	1657
53.	GEO . MICCARTNAY .	OF . BELLFAST .	1656
54.	GEORGE . MARTIN . OF .	BELFAST . MARCHAN .	1637
55.	GEORGE . MARTIN . OF .	BELFAST . MARCHANT .	1666
56.	GEORGE . MICARTNE^{Y}	OF . BELFAST .	1657
57.	HENRY . SMITH . IN .	BELFAST . MERCH^{T}	
58.	HVGH . DVOK .	IN . BELLFAST .	1656
59.	HVGH . ECCLES . OF .	BELLFAST . MARCHANT .	
60.	HVGH . SPAIRE . MARCHANT .	IN . BELFAST . HIS . PENNY .	
61.	HVMPHRY . DOBBIN . OF .	BELFAST . MARCH^{T}	1670
62.	IAMES . BIGGER . MARCHAN .	IN . BELFAST .	1666
63.	IAMES . CHALMERS . IN .	BELFAST . MARCHANT .	1670
64.	IOHN . BVSH . BELFAST .	I^{D}	
65.	IOHN . BVSH . BELLFAST .	I^{D}	

66.	IOHN . CLVGSTON .	IN . BELFAST .	1657
67.	IOHN . CLVGSTON .	IN . BELFAST . MARCH^{T}	
68.	IOHN . CORRY . OF .	BELLFAST . MARCHANT .	1656
69.	IOHN . GIVAN .	IN . BELFAST .	
70.	IOHN . KILPATRICK .	IN . BELFAST . MARCHT .	
71.	IOHN . STEWARD . OF .	BELFAST .	1656
72.	IOHN . STEWART . HIS . I^{D}	THE . ARMES . OF . BALFAST .	1657
73.	IOSIAH . MARTIN .	IN . BELFAST .	1657
74.	MICHAELL . BIGGER .	OF . BELLFAST .	1657
75.	ROBERT . WHITSIDE . IN .	BELLFAST . MARCHANT .	1667
76.	WILL . LOKART . THO . AITKIN .	MERCHANTS . IN . BELFAST .	
77.	WILLIAM . MOORE .	*History of Belfast*, p. 81.	
78.	WILLIAM . SMITH .	OF . BELFAST .	1657
79.	WILLIAM . SMITH .	IN . BELFAST .	

BELLEMANOGH, CO. ANTRIM.

80.	IOHN . HARPER . MARCH^{T}	IN . BELEMENOCKE .	
81.	IOHN . WA*** . MARC* .	IN . BELLEMENOCK .	1671
82.	ROBART . BOYD . MAR .	IN . BELLEMANÓGH .	
83.	WILLIAM . ADARE .	IN . BELLIMINOCH .	

BELTURBET, CO. CAVAN.

84.	ROBART . HARES . AT .	BELLTVRBRATT . **** .	

BIRR, KING'S COUNTY.

85.	MARCVS . ARCHER . OF .	BIRR . MARCHANT .	
86.	MICHAELL . CANTWELL .	OF . BIRR . MARCHANT .	
87.	RICHARD . ARCHER .	OF . BIRR . MARCHAN .	1667
88.	BY . ROBERT . IEFFES . OF . BIRR . TO . PASS . FOR . I . D.	IN . NECESSARY . CHAINGE . WITH . LABOVRERS . AN . OTHERS .	
89.	THOMAS . LANGTONN . IN .	BIRR . MARCHANT .	

BORRISOKANE, CO. TIPPERARY.

90.	THOMAS . WOOLLFORD .	MARCHANT . OF . BVRRISCANE .	1668

BORRISOLEIGH, CO. TIPPERARY.

91.	STEPHEN . RADFORD .	BVRRESOLE . MARCH .	

BOYLE, CO. ROSCOMMON.

92.	CORMOCK . DERMOTT . OF .	ABBEY . BOYLE . **** .	1658
93.	STEPHEN . DOWDALL .	OF . BOYLL . MERCHANT .	

BROUGHSHANE, CO. ANTRIM.

94.	SAMVEL . ANDREW . M^{RT}	IN . BROVGHSHAIN .	

CALEDON, CO. TYRONE.

95.	IOHN . SPEARE . OF .	CALLEDON . TANER .	

CARLOW, CO. CARLOW.

96.	GARRETT . QVIGLEY .	OF . CARLO . MARCH .	
97.	THO . REYNALDS .	OF . CARL** . TANER .	

CARRICK, CO. TIPPERARY.

98.	PEETER . AYLWARD .	CARRICK . MARC .	
99.	WALTER . DEVEREVX .	OF . CARRIKE . MAR .	—69

CARRICKFERGUS, CO. ANTRIM.

100.	ANDREW . WILLOVGHBY .	OF . CARRICKFARGVS .	
101.	ANTHONY . HALL . IN .	CARRICKFERGVS .	1656
102.	ANTHONY . HALL . IN .	CARRICKFERGVS .	
103.	A . I^{D} . H .	*A Castle.* C . F . B .	
104.	HENERY . BVRNES .	IN . CARRICKFERGVS .	
105.	IOHN . DAVADYS .	*M'Skimmin's History of Carrickfergus.*	
106.	IOHN . WADMAN .	CARRICKFERGVS .	
107.	WILLIAM . STVBBS .	*M'Skimmin's History of Carrickfergus.*	

CARRICKMACROSS, CO. MONAGHAN.

108.	W . B . AT . CARACKMACROSSE .	WHEN . YOV . PLEASE . ILE . CHANGE . THES .	
109.	W . B . AT . CARACK . NA^{R}ROSS .	WHEN . YOV . PLEASE . ILE . CHAINGE . THES .	

CASHELL, CO. TIPPERARY.

110.	EDMOND . KEARNEY .	CASSHEL . HALFEPENY .	
111.	EDMOND . KEARNEY .	CASSHEL . MARC^{T}	
112.	EDWARD . MIHILL .	OF . CASHALL .	
113.	IOHN . NEVE .	IN . CASSHELL .	
114.	IOHN . PEENE .	IN . CASSHELL .	

115.	PEETER . BOYTON .	OF . CASHILL . MARCH^{N}	
116.	ROBART . PRINCE .	OF . CASHELL .	1664

CASTLECHICHESTER, CO. ANTRIM.

117.	ROB . BRICE . AVTH .	CASTLECHICHESTER .	1671

CASTLEDERMOT, CO. KILDARE.

118.	HENERY . MARRENER .	OF . CASTLEDERMOTT .	

CHARLEMONT. CO. ARMAGH.

119.	THOMAS . CHADS . MERCHANT .	IN . CHARLEMONT .	

CHARLEVILLE, CO. CORK.

120.	A . W . PENNEY .	C . CHARLIVELL .	1667
121.	EDMOND . YEOMANS . HIS . PENNY . IN . CORK .	(*Countermarked,*) CHARLEVILE .	
122.	IOHN . BVTTELER . & . IOHN . EXHAM .	IN . CHARLEVILLE .	1668
123.	ROBERT . COWEN . ^{W}. IN .	CHARLEVILE .	—79

CLARE, *see* LIMERICK.

CLONAKILTY, CO. CORK.

124.	*Coat of Arms.*	****GHNIKILTY . PE . (*countermarked,*) I . B . FARTHING .	

CLONES, CO. MONAGHAN.

125.	WILLIAM . PARKE . IN .	CLOWNIS . MARCHAN .	1664

CLONFERT. CO. GALWAY.

126.	THOMAS . BVTLER . MARCHANT.	OF . CLONFERT .	1676

CLONMEEN, CO. CORK.

127.	CLONMEEN . PENNEY .	*A Tree behind a Quadruped.*	

CLONMEL. CO. TIPPERARY.

128.	ANDREW . ROBESON . OF .	CLONMEL . HIS . I^{D}	
129.	ANDREW . ROBESON . OF .	CLONMEL . HIS . (½^{D} *countermarked.*)	
130.	ANN . HENBVRY .	IN . CLONMELL .	1663
131.	GEORGE . CARR .	OF . CLONMELL .	1656

132.	I . B . OF . CLONMELL .	FOR . CITTY . AND . COVNTY .	1658
133.	RICHARD . CARLETON . OF .	CLONMELL . MERCHANT .	
134.	RICHARD . HAMERTON .	IN . CLONMELL .	1657
135.	RICHARD . HAMERTON .	OF . CLONMELL .	1664
136.	WILLIAM . HENBVRY . OF .	CLONMELL .	1656

CLOWNIS, *see* CLONES.

COLERAINE, CO. LONDONDERRY.

137.	ALEXANDER . MILLER .	IN . COLRAINE . MARCHANT .	1665
138.	GILBERT . W ? ********** .	** . ***RANE . MA** .	
139.	HVGH . M**** . MAR** .	IN . COL****** .	
140.	IOHN . BROWNE .	COLRENE . MAR .	
141.	IOHN . BROWNE . MARCH^{T}	IN . COLERAINE .	
142.	WIL . ROSE . OF . COLRAINE .	EXCHANGE . FOR . A . CAN .	
143.	WIL^{M} . ROSE . OF . COLRAINE .	HIS . EXCHANGE . FOR . A . CAN . (*of Beer.*)*	

CONNAUGHT.

144.	IA . BROWNE . FARMER .	OF . EXCISE . IN . CONAGHT .	

CORK, CO. CORK.

145.	CORK . CITTY . P . M . MAYOR .	*A Ship and Castle.*	1658
146.	CORK . (*A square piece*).	*A Castle.*	
147.	CORKE .	*Blank on reverse.*	
148.	A . CORKE . FARTHING .	A . CORKE . FARTHING .	
149.	A . CORCK . HALFPENNY .	C . C .	1656
150.	A . CORK . PENNY . C . C .	THE . ARMES . OF . CORK .	1659
151.	EDMOND . YEOMANS . HIS . PENNY . IN CORKE .	*Adam and Eve in Paradise.*	1678
152.	EDMOND . YEOMANS . HIS . PENNY . IN . CORKE .	(*Countermarked,*) CHARLEVILE .	
153.	EDWARD . GOBLE . OF .	CORK . BRAZIER .	1672
154.	EDWARD . KAVENACH .	OF . CORKE . MARCHAN .	
155.	GEORGE . YOVNG .	IN . CORKE .	1657

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* In the field of the reverse there is a *Bear;* on the obverse a Rose. These symbols are transposed on No. 142, which renders the meaning obscure without the evidence of No. 143.

156.	IONAS . MORRIS . OF . CORK .	*A Ship and Castle.*	
157.	IONAS . MORRIS . OF . CORK .	*A Ship and Castle.*	1657
158.	WILLIAM . BALLARD . HIS . PENNY . IN . CORKE .	*Royal Oak.*	1667

COWRY (GOREY? CO. WEXFORD).

159.	EDWARD . CAVENACH .	OF . COWRY . MARCH^{T}	

DINGLE, CO. KERRY.

160.	A . DINGLE . PENNY .	*A man with a bow, &c.*	1679

DOWN, COUNTY OF.

161.	ARTHVR . SQVIRE .	COVNTY . OF . DOWNE .	

DOWNPATRICK, CO. DOWN.

162.	IAMES . STEWART . MERCHANT.	HIS . TOKEN . IN . DOWN . (DEC. *in the field.*)	1658
163.	IAMES . THOMSON . MA .	IN . DOWNE . PATRICK .	1670
164.	IOHN . LAWE .	DOWNEPATRICK .	
165.	SENESCHALL . HIS . TOKEN .	OF . DOWNEPATRICK .	
166.	WILLIAM . THOMSON .	OF . DONNPATHRICKE .	

DROGHEDA, CO. LOUTH.

167.	ANDREW . HAMLIN . OF .	DROGHEDA . MARCHANT .	
168.	EDWARD . BYTHELL .	OF . DROGHEDA . MARCHANT .	
169.	EDWARD . MARTINE . IN . (HIS . HALFPENY) .	DROVGHEDA . MARCH^{T}	
170.	EDWARD . MARTTIN .	OF . DROGHEDA .	
171.	FRANCIS . POOLE . OF	DROGHEADE . MARCHANT .	1656
172.	HEN . COKER . OF . DROHEDAES . IRELAND .	IO . HAYENS . ON . Y . KEY . DUBLIN .	1656
173.	HEN . COKER . OF . DROHEDAES . IRELAND .	FOR . NECESSARY . CHANGE . A . PENNY . TOK' .	1660
174.	HUGH . FOWKES . OF .	DROGHEDA . GLASER .	
175.	HUGH . FOWKES . OF .	DROGHEDA . GLASYR .	
176.	IOHN . BELLEW . OF .	DROGHEDA . MARCH .	
177.	IOHN . BRENNAN .	OF . DROHEDA .	1663
178.	IOHN . KILLOGH .	OF . DROHEDA . MARCH .	
179.	IOHN . LEY . IN .	DROGHEDA . MARCHANT .	1657

180.	IOHN . LEY . MARCHANT .	IN . DROGHEDA .	1664
181.	LEBBEVS . LOWND . A . HALPENY .	DROGHADA . GROSER .	1667
182.	LVKE . CONLY . OF . DROGHEDA . HIS . PENY.	MARCHANT .	1670
183.	OLIVER . BIRD . OF .	DROCHEDA . MARCHANT .	
184.	RICHARD . IACKSON .	OF . DROGHEDA . MARCHA^{T}	
185.	RICHARD . TIRELL . OF .	DROGHEDA . MARCH^{T}	
186.	SAML . STANBRIDG .	OF . DROGHEDA .	1653
187.	THOMAS . P****RD . OF .	DROGHADA . MARCHANT .	

DROMORE, CO. DOWN.

188.	EDWARD . HALL .	IN . DROMORE . EVAGH .	
189.	IOHN . GVTHRY .	IN . DROMORE .	1663
190.	PHELEM . MAGENIS .	OF . DROMORE .	
191.	WILLIAM . HALTRIGE .	OF . DROMOR .	1668

DUBLIN, CO. DUBLIN.

192.	THE . DVBLIN . HALFPENNIE .	LONG . LIVE . THE . KING .	1679
193.	ALEX . AICKIN . MARCHAN .	IN . SKINER . ROW . DVBLIN .	
194.	ALEXANDER . AICKIN . MARCHANT .	IN . SKINER . ROW . DVBLIN .	—68
195.	ANDREW . LLOYD . IN .	DVBLIN . MARCHANT .	—58
196.	ANTHONY . DERREY . IN .	CASTLE . STREET . DVBLIN .	1657
197.	ARLENTER . VSHER . FISH .	SHAMBLES . STREET . DVBLIN .	
198.	ARLENTER . VSHER . IN . FISH .	SHAMBLES . STREET . DVBLIN .	
199.	ARTHVR . HARVIE . IN .	DVBLIN . MARCHANT .	
200.	ARTHVR . HARVEY . IN . HIGH .	STREETE . IN . DVBLIN .	1656
201.	ARTHVR . HARWIE .	IN . DVBLIN .	1653
202.	CHRISTO . BENNETT .	MARCHANT .	1656
203.	CHRISTOPHER . BENNET . THO .	STREET . DVBLIN . MARCHANT .	
204.	CHRISTOPHER . BENNET . IN . S^{T}	THOMAS . DVBLIN . MARCHANT .	
205.	CHRISTOPHER . CIFFAR .	OF . DVBLIN . MARCH .	
206.	DENNIS . QUINNE .	MEARCHANT . IN . DVBLIN .	1654
207.	EDMOND . THOMPSON .	IN . DVBLIN .	1665
208.	EDMVND . SPRING .	IN . DVBLIN . MARCHANT .	
209.	EDWARD . HARRIS .	IN . COPPER . ALLY . DVBLIN .	
210.	EDWARD . MICHELL . OF .	OXMANTOWNE . DVBLIN .	

211.	EDWARD . WAYNMAN .	IN . CORKE . HILL . DVBLIN .	
212.	ELNATHAN . BROCK .	IN . DVBLIN .	1656
213.	ELNATHAN . BROCKE .	IN . DVBLIN .	1654
214.	ELVATHAN . BROCKE .	IN . DVBLINE .	1657
215.	GEO . DICKINSON . DVBLIN .	IN . CHEKER . LANE . M****.	1657
216.	GEORGE . GILBERT .	BRIDG . STREET . DVBLIN .	
217.	GERRARD . COLLEY . AT . RED . +	IN . HIGH . STREET . DVBLIN . APOTHECARY .	
218.	GILBERT . IOHNSON . IN .	THOMAS . STREET . DVB .	
219.	HENRY . BOLLARDT .	APOTICARY . IN . DVBLIN .	1654
220.	HENRY . BOLLARDT .	APOTICARY . IN . DVBLIN .	1663
221.	HENRY . MARTYN .	SKINNER . ROW . DVBLIN .	1668
222.	HENRY . REYNOLDS . IN .	HIGH . STREET . DVBLIN .	
223.	HENRY . RVGGE . APOTHECARY .	IN . CASTLE . STRET . DVB .	
224.	HENRY . RVGGE . APOTHECARY .	IN . CASTLE . STREET . DVB .	
225.	HENRY . WARREN . IN . HIGH . STRET . IN . DVBLIN .	*Coronet and Feathers.*	
226.	HENRY . YEATES .	IN . COPPER . ALLY . DVBLIN .	
227.	IAMES . CLEERE . IN .	BRIDG . STREETE . DVB .	
228.	IAMES . KELLEY . IN .	NICOLAS . STREET . DVBLIN .	
229.	IESPAR . ROADS . BARBADAS .	CASTELL . STREET . DVBLIN .	1657
230.	IGNATIUS . BROWNE . IN .	HIGH . STRET . DVBLIN . PEVT"	1671
231.	IO . DEMYNIERS . DVBLIN .	SVGAR . LOFE . BRIG . STRE .	
232.	IO . FLOOD . HIGH . STREET .	DVBLIN . MARCHANT .	
233.	IO . HAYENS . ON . Y . KEY . DVBLIN .	HEN . COKER . OF . DROHEDAES . IERLAND .	1656
234.	IO . PARTINGTON . GOVLDSME .	KINGES . HEAD . SKINNOR . ROW . DVBLIN .	
235.	IOH . SMITH . IN . HIGH . STRE .	IN . DUBLINE . MARCHANT .	
236.	IOHN . BETSON . AT . Y . WHITE . LION .	IN . HIGH . STREETE . DVBLIN . MAR .	
237.	IOHN . BRERETON . OF .	DVBLIN . MARCHANT .	1667
238.	IOHN . BVSH . OF . DVBLIN .	IN . CASTLE . STREET .	
239.	IOHN . BVSH . OF . DVBLIN .	IN . CASTLE . STREETE .	1656
240.	IOHN . COOKE . GROCER .	THOMAS . STREET . DVBLIN .	
241.	IOHN . DVTTON . IN . THOMAS .	STREET . IN . DVBLIN .	1665
242.	IOHN . FORRIST . AT . THE .	BRIDG . FOOTE . DVBLIN .	
243.	IOHN . FOXALL . AT . THE . SIGNE .	OF . THE . FOX . IN . DVBLIN .	

244.	IOHN . FOXALL . AT . YE . SIGNE .	OF . THE . FOX . IN . DVBLIN .	
245.	IOHN . HOO** . AT . THE .	TIMBER . YARD . IN . DVBLIN . DAMAS . STREET .	
246.	IOHN . LOVETT . IN .	THOMAS . STRET . DVBLIN .	1657
247.	IOHN . MOXON . IN . SKINER .	ROWE . IN . DVBLIN .	1667
248.	IOHN . NICHOLAS . OF .	DVBLIN . MARCHANT .	
249.	IOHN . PVLLER . IN .	FISHAMBLE . STREET . DVBLIN .	
250.	IOHN . SEAWELL . BRASER .	IN . SKINER . ROW . DVBLIN .	
251.	IOHN . SENDELL . IN . S^{T}	FRANCIS . STRET . DVB .	
252.	IOHN . SWEETMAN . IN .	DVBLIN . CORN . MARKET .	
253.	IOHN . TOTTIE . AT . THE .	BRIDGFOOTE . DVBLIN .	1657
254.	IOHN . TOTTIE . MARCHANT .	IN . DVBLIN .	1663
255.	IOHN . WARREN . HIGH . STREET .	DVBLIN . TALLOW . CHANDLR .	
256.	ISAAC . TAYLER . IN .	SKINER . ROW . DVBLIN .	1657
257.	LEWIS . DES . MENIERES .	MARCHANT . IN . DVBLIN .	
258.	LEWIS . DES . MYNIERES .	OF . DVBLIN . MERCHANT .	
259.	LIONEL . NEWMAN . THE . COFFEE . HOVSE . IN . DVBLIN .	*A Lion rampant.*	1664
260.	MARKE . QVINE . APOTHYCARY .	IN . DVBLIN .	1654
261.	MARTIN . DIX . IN .	CORNE . MARKET . DVB .	
262.	MARY . DRINKWATER . IN .	SKYNNER . ROW . IN . DVBLIN .	1657
263.	MATHEW . FRENCH .	HIGH . STREET . IN . DVBLIN .	1655
264.	MIC . WILSON . OF . DVBLIN .	HIS . HALFPENY .	1672
265.	NICH . DELAMAIN . IN .	STONI . BETTER . DVBLIN .	
266.	NICHOLAS . HARRIS . TALOW .	CHANDLER . IN DVBLIN .	
267.	NICHOLAS . WHITE . IN .	HIGH . STREET . IN . DVBLIN . HIS . PENY .	
268.	OWEN . KELLY . IN .	SKINER . ROW . DVBLIN .	1666
269.	RANDAL . LESTER .	IN . THOMAS . STREET . DVBLIN .	1655
270.	RICH . SIMKIN . OF .	DVBLIN . MARCHAN^{T}	
271.	RICH . TYLE . OF . ST .	PATRICKS . CLOSE . DVBLIN .	
272.	RICHARD . CHESSES . IN .	S^{T} . WARBERS . STR . MARCH^{T} . DVB .	
273.	RICHARD . COOKE . OF .	DVBLINE . MARCHANT .	
274.	RICHARD . GRENWOOD . MAR .	HIGH . STRET . DVBLIN .	
275.	RICHARD . HOVGHTON .	OF . DVBLIN . MARCHANT .	
276.	RICHARD . MARTIN .	CASTEL . STREET . DVBLIN .	1657
277.	RICHARD . WARREN . MARCH^{T} IN .	S^{T} . THOMAS . STREET . DVBLIN .	1667

278.	RIDGLEY . HATFEILD .	IN . DVBLIN . MARCHANT .	1654
279.	ROBERT . BATRIP . IN .	CASTELL . STRET . DVBLIN .	1657
280.	ROBERT . FREEMAN . IN . DVBLIN .	CASTLE . STREET . MARC .	
281.	ROBERT . HVCHINS .	SWAN . BLIND . KEY .	
282.	ROBERT . PARTINGTON .	IN . DVBLIN . MARCHANT .	
283.	ROGER . HALLEY . OF . DVBLIN .	ARTIZEN . AND . SKINNER . IN SKINNER . ROWE .	
284.	SAMVEL . SALTONSTON .	IN . DVBLIN . MARCHANT .	
285.	SAMVEL . SALTONSTONE .	IN . DVBLIN . MARCHANT .	
286.	SAMVEL . WESTON .	MARCHANT . IN . DVBLIN .	1654
287.	STEPHEN . CLARK . DVB .	CHRIST . CHVRCH . YARD .	
288.	SYMON . CARCK .	IN . BRIDG . STRET . DVBLIN .	
289.	THO . FLOOD . HIGH . STRET .	DVBLIN . MARCHANT .	
290.	THO . GOVLD . MARCHANT .	IN . HIGH . STRET . DVBLIN .	
291.	THO . LOWEN .	IN . PATRICK . STREET . DVBLIN .	
292.	THO . PAGETT . TALLOW .	CHANDLER . HIGH . STREET . DVBLIN .	
293.	THOMAS . OR****** .	BRIDG . FOOT . DVBLIN .	
294.	THOMAS . S**GHT .	EXCHANG . CHRIST . CHVRCH . YARD . DVB .	—65
295.	WALT . BRCE . IN . CORN .	MARKET . DVBLIN .	
296.	WALTER . HARRIS . OF .	DVBLIN . MARCHANT .	
297.	WALTER . MOTTLEY . MARCH .	IN . BRIDG . STREET . DVBLIN .	
298.	WARNAR . WESTENRA .	IN . DVBLIN . MARCHANT .	1655
299.	WIL . BROOKING . OF .	DVBLINE . HABERDASHE^{R}	
300.	WILL . EVES . MARCHANT . IN .	NICHOLAS . STRET . DVBLIN .	
301.	WILL . HILL . SKENER . ROW .	PESTELL . AN . MORTAR . DVBLIN .	165
302.	WILL . MOVNT . MARCH^{T} . IN .	CHRIST . CHVRCH . YARD . DVBLIN .	
303.	WILL . TAYLOR . MARCHAN^{T}	IN . SKINNER . ROW . DVBLIN .	
304.	WILLAM . STOKS . IN . HIGH . STR .	IN . DVBLIN . MARCHANT .	1671
305.	WILLIAM . BARRET .	CHRIST . CHVRCH . YARD . DVBLIN .	
306.	WILLIAM . COLLYS . IN .	SKINNER . ROW . DVBLIN .	1666
307.	WILLIAM . ETGER . IN .	DVBLIN . MARCHANT .	1663
308.	WILLIAM . HVLME . IN .	HIGH . STREET . DVBLIN .	

DUNDALK, CO. LOUTH.

309.	DVNDALKE .	CORPORATION .	1663
310.	BRANWAITE . CEASAR . OF .	DVNDALKE . MARCHANT .	

311.	GEORGE . LAMBERT . OF .	DVNDALKE . MARCHANT .	
312.	IOHN . WILSHIER . F . OF .	DVNDALKE . MARCHANT .	
313.	OATES . CRO****** .	MARCHANT . DVNDA** .	—6

DUNGANNON, CO. TYRONE.

314.	IAMES . HANNA .	IN . DONGANON . MARCH .	
315.	RO . NELLSON . OF .	DVNGANON . APOTHECRY .	
316.	ROB . NELLSON . OF .	DANGONNON . POTHERY .	

DUNGARVAN, CO. WATERFORD.

317.	THOMAS . NICOLL .	OF . DVNGARVAN .	1677

EDGEWORTHSTOWN, CO. LONGFORD.

318.	FRANSIS . WELSH . IN .	EDGWORTH . TOWNE .	—74

ELPHIN, CO. ROSCOMMON.

319.	ANDREW . MAR*** .	OF . ELFINE . MARC .	

ENNIS, CO. CLARE.

320.	DAVID . WH***** . IN .	ENNIS . A . PENY .	

ENNISKEAN, CO. CORK.

321.	HENRY . WH***N . MERCHANT .	IN . ENISKEAN . HIS . PENNY .	1678

ENNISKILLEN, CO. FERMANAGH.

322.	ABRAHAM . CLEMENTS .	OF . INISKILLEN . MARC .	—57
323.	DAVID . RYND .	ENISKILLIN . MARC .	
324.	WILLIAM . COOPER .	IN . INISKILLIN .	

FOURE, CO. WESTMEATH.

325.	GAROTT . TYRELL .	OF . FOVRE .	

GALWAY, CO. GALWAY.

326.	ABR^{M} . CHRISTIAN .	MARCH^{T} . IN . GALLWAY .	1670
327.	ALDRIGE . SADLER .	GALLAWAY . BAKER .	
328.	AMBROS . LYNCH . OF .	GALLWAY . MARCHAN .	
329.	BAR . FRENCH . MARCHANT . LAT . OF . GALWAY .	(*Reverse detrited.*)	
330.	DOMINICK . FRENCH .	OF . GALLWAY . MARCH .	1664

331.	DOMINICKE . LYNCH .	OF . GALLWAY .	1665
332.	EDWARD . ORMSBY . OF .	GALLWAY . MARCHANT .	
333.	FRANCIS . BANCKES . OF .	GALLWAY . PEWTERER .	
334.	GEORG . DAVISON . IN . HIGH .	STREET . IN . GALLOWAY .	
335.	GEORGE . STANTON .	GALLWAY . MACHANT .	
336.	IARVIS . HINDE .	OF . GALLAWAY .	
337.	IOHN . BODLE . OF .	GALLAWAY . MACHAN .	
338.	IOHN . GROME . MARCHANT .	OF . GALLWAY . VIVE . LE . ROY .	1664
339.	IOHN . MORREY . OF .	GALLWAY . MARCHANT .	
340.	MARCVS . LYNCH . OF .	CALLWAY . MARCHAN .	
341.	PATR . BROWNE . MERC^T	IN . GALLWAY .	1669
342.	PEETER . PARR . MERCHANT .	IN . GALLWAY .	1669
343.	RICHARD . ORMSBY .	IN . GALLWAY . MARCHANT .	1665
344.	ROB . WARNER . MARCH .	IN . GALLAWAY .	1664
345.	THO . BROVGHTO^N . MARCH^T	IN . GALLWAY .	1669
346.	THOMAS . BROWNE . OF .	GALLAWAY . MARCHAN .	
347.	W***ER . HICKES . MERCHANT .	AT . GALLWAY . HIS . PENNY .	1669
348.	WILL . STANLY . OF . GALWAY .	*Coat of Arms.*	1659

GLASSLOUGH, CO. MONAGHAN.

349.	IOHN . PATERSON .	IN . GLASELOCH .	1671

GLENARM, CO. ANTRIM.

350.	ARCHIBALD . ADDAIRE .	MAR . IN . GLENARME .	

GOREY, *see* COWRY.

GOWRAN, CO. KILKENNY.

351.	FRANCIS . BARKER .	OF . GORON .	1656

HOLLYWOOD, CO. DOWN.

352.	IAMES . SIM . OF .	HOLLYWOOD .	

INESCRONE, CO. SLIGO.

353.	THO . GOODIN . MARCHANT.	OF . INESCRONE .	1663

JAMESTOWN, CO. ROSCOMMON.

354.	BRYAN . BEIRNE . OF .	IAMESTOWNE . MARCH^T	1658

KELLS, CO. MEATH.

355.	EDWARD . DYES . OF .	KELLS . MARCHANT .	1669
356.	IGNATIVS . FLEMING .	OF . KELLY . MERCHANT .	

KERRY.

357.	KERY . T . S .	*The Commonwealth Arms.*	
358.	IN . THE . COVNTY .	OF . KERRY .	

KILBEGGAN, CO. WESTMEATH.

359.	HEN . DAY . KILLBEG'N .	C^{o}. WESTMEATH .	
360.	RICHARD . HARISON . OF .	KILBEGAN . MARCHAN .	1658

KILDARE, CO. KILDARE.

361.	IAMES . MONEY . OF .	KILDARE . MARCH .	

KILFENA, CO. LIMERICK.

362.	IOHN . GODSELL . OF .	KILFENA .	

KILFINAN, CO. LIMERICK.

363.	IOHN . GODSELL . OF .	KILLFINAN .	1667

KILKENNY, CO. KILKENNY.

364.	FOR . THE . ***** .	KILKENNY . ***** .	1659
365.	EDWARD . ROTH . MARCHANT .	IN . KILKENNY .	1663
366.	EDWARD . SEWELL . OF .	KILLKENY . TALLOW . CHAN .	
367.	IAMES . PVRCELL .	IRISHTOWNE . KILLNY .	
368.	IOHN . BEAVOR .	OF . KILKENY .	
369.	IOHN . BOLTON .	KILKENNY .	
370.	IOHN . LANGTON . IN .	KILKENNY . MAR .	
371.	IOHN . WHITTLE . IN .	KILKENY .	1656
372.	LUCAS . WALE . OF .	KILKENY . MERCHANT .	
373.	PETER . GOODIN . OF .	KILKENY . MARCHANT .	
374.	RALPH . SKANLAN .	KILLKENY .	1656
375.	RICHARD . INWOOD .	KILKENNY .	
376.	THOMAS . ADAMS .	KILKENNY . PENY .	1658
377.	THOMAS . ADAMS .	KILKENNY . HAPENY .	1658
378.	THOMAS . DAVIS . KILKENY .	EXCISE . OFFIS .	
379.	THOMAS . NEVELL . OF .	KILKENY .	1658
380.	WILLIAM . KEOVGH .	KILKENY . GOLDSMITH .	

KILLYLEIGH, CO. DOWN.

381.	ALEX. *** AD . OF.	KILLILEAH . MERCHAN.	16*8
382.	DAVID . POLLOK . IN .	KILLILEAGH . COVNTY . **** .	1664
383.	IAMES . WILLIAMSON .	IN . KILILEAH . MARCH^{T}	1668

KILMALLOCK, CO. LIMERICK.

384.	IAMES . CARPENTER . MARC .	OF . KILMALOCK .	
385.	MATHEW . MEADE . MERCHAN .	KILMALOCK .	1673

KILREA, CO. LONDONDERRY.

386.	NICHOLAS . EDWARDS .	OF . KILREA .	1678

KILWORTH, CO. CORK.

387.	CHRISTO . CROKER .	OF . KILLWORTH .	1667

KINSALE, CO. CORK.

388.	KINSALE .	*A Portcullis.*	1677
389.	A . K . SALE . PENNY .	*Coat of Arms.*	1668
390.	THE . KINSALE . PENNY .	*Coat of Arms.*	1659
391.	IOHN . WATTS . OF .	KINGSALE .	1668
392.	THOMAS . BURROWES .	OF . KINGSA** .	1667
393.	WILLIAM . B**NDE .	OF . KINSALE . **** .	

LANNBEG, CO. ANTRIM.

394.	THO . RICKABIE .	IN . LANNBEGG .	

LAZEY HILL, CO. DUBLIN.

395.	NIC . DELONE . LAZY . HILL .	*Adam and Eve.*	
396.	NICHOLAS . ROCHFORD .	LAZEY . HILL .	

LETTERKENNY, CO. DONEGAL.

397.	WILLIAM . ANDERSO^{N} . OF .	LATERKENIE . MARCH^{T}	

LIMERICK, CO. LIMERICK.

398.	LIMERICK .	CLARE .	
399.	LIMERICK . BVTCHERS .	HALFPENNY .	1679
400.	CITY . OF . LIMERICK .	CHANGE . & . CHARITY .	1658
401.	CITTY . OF . LIMERICK .	CHANGE . & . CHARITY .	1658
402.	ANTHONY . BARTLETT .	MERCHANT . OF . LYMERICK .	1671

403.	ANTHONY . BARTLETT .	MERCHANT . OF . LYMERICK .	
404.	ED . WIGHT . OF . LIMBRICK .	HIS . HALFPENY .	1677
405.	ED . WIGHT . OF . LIMBRIK .	HIS . HALFPENY .	1677
406.	EDWARD . CLARKE .	OF . LYMERICK .	1670
407.	EDWARD . CLARKE .	OF . LYMERICK . ½ .	
408.	IOHN . BELL . MERCH^{T}	IN . LIMRICK .	
409.	IOHN . BENNET . MERC .	LYMRICK . PENNY .	1668
410.	RICHARD . PEARCE . OF .	LIMRICK . APOTHECAR .	1668
411.	ROWLAND . CREAGH .	LYMRICK . MERCH .	
412.	THO . LINCH . OF . LIMRICK .	HIS . HALFPENY . TOKEN .	1679
413.	THOMAS . MARTEN .	MERCHANT . IN . LYMRICK .	1669
414.	WILLIAM . ****** .	IN . LIMBRICK . HIS . HALFPENY .	1679

LISBURN, CO. ANTRIM.

415.	ADDAM . LEATHES .	OF . LISBVRNE . GENT .	
416.	EDWARD . MOORE .	IN . LISBVRNE .	1666
417.	IO . P*** . LISBORN . MAR .	*The old Market-house.*	

LISMALIN, CO. TIPPERARY.

418.	GARRET . QVIGLEY .	IN . LISMALIN .	1659

LISNEGARVY,[*] CO. ANTRIM.

419.	BRIAN . MAGEE .	IN . LISNEGARVY .	
420.	DENIS . MAGEE . MARCH^{T}	OF . LISNEGARVY .	
421.	OLIVER . TAYLOR . MERCE^{R}	IN . LISNEGARVY .	
422.	OLIVER . TAYLOR . MR .	IN . LISNEGARVY .	1658
423.	W . R . D . M .	LISNEGARVIE .	1656

LONDONDERRY, CO. LONDONDERRY.

424.	CLOATHINGE . IN . L . DERRY .	FOR . FISHING . AND . EXCH .	
425.	I**** . S****** .	IN . LON******* .	166*
426.	IAMES . BARTON .	OF . LONDONDERY .	1666
427.	IAMES . CONINGHAM .	IN . LONDONDERRY .	—68
428.	IOHN . BVCHANAN .	OF . LONDONDERRY .	
429.	SAMVEL . DAWSON .	LONDONDERRY . MER .	
430.	SAMVEL . RATCLIFFE .	OF . LONDON . DERRY .	
431.	WILLIAM . RODGER . OF .	LONDON . DERRY . MARCH^{T}	

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[*] The ancient name of Lisburn.

LONGFORD, CO. LONGFORD.

432.	ROGER . FARELL . OF .	LONGFORD .	

LOUGHGALL, CO. ARMAGH.

433.	ROBERT . BENNETT . IN .	LOCHGALL . MARCHAN^{T}	

LOUGHREAGH, CO. GALWAY.

434.	CHRISTOFER . POORE .	LOVGHREAGH . MER .	
435.	CHRISTOPHER . FRENCH .	OF . LAVGHREAGH . MER .	1656
436.	EDMOND . KELLY . OF .	LOVGHREAGH . MAC .	
437.	IOHN . POORE . OF .	LOGHREAGH .	
438.	LAVRENCE . MOORE .	LOVGHRE . MERCHAN .	
439.	RICHARD . HARRIS .	LOVGHREGH . SKNER .	—77
440.	***** . POWER .	LOVGHREAGH . MAR .	

LURGAN, CO. ARMAGH.

441.	THOMAS . WHITE .	OF . LVRGAN .	1666

MAGHERAFELT, CO. LONDONDERRY.

442.	HVGH . RAINEY . OF .	MAGHRYFELT . MERCH .	1671
443.	WILLIAM . RAINEY .	OF . MAIGHEREYFELT .	1668

MAGHERALIN, CO. ARMAGH.

444.	GILBERT . FERGESON .	OF . MAHERLIN . MARCH .	

MAGHERAMORNE, CO. ANTRIM.

445.	IOHN . BVRNES . IN . MACHRIMORN . IN .	HIS . PENIE .	1672
446.	IOHN . BVRNES . ROMINM . *****NIN .	HIS . PENEY .	1672

MANORHAMILTON, CO. LEITRIM.

447.	GEORGE . ROBB . MERCHANT .	OF . MANERHAMLEITON .	

MARYBOROUGH, QUEEN'S CO.

448.	EDWARD . NICHOLIS .	OF . MAREBROVGH .	
449.	IAMES . PRENDERGAST .	OF . MARYBOROVGH .	
450.	IOHN . PARTRIDGE . OF .	MARYBOROVGH .	1658
451.	WALTER . GORMAN . OF .	MARYBOROVGH .	

MAYNOOTH, CO. KILDARE.

452.	RALPH . ****OCK . OF .	MAYNOO** . **** .	

MONAGHAN, CO. MONAGHAN.

453.	GEORGE . CVNNINGHAM .	MANAGHANE . MARCH .	1664
454.	ROBERT . AGNEW . IN .	MONOGHAN . MARCHANT .	

MONASTEREVEN, CO. KILDARE.

455.	NAT . SWAINE . TANNER .	IN . MONSTEREVEN .	1673
456.	ROBERT . HOBSON . MARC^{T}	IN . MONSTEREVEN .	

MONEYMORE, CO. LONDONDERRY.

457.	DAVID . BELL . MARCHANT .	IN . MVNNYMORE . HIS . PENNY .	1671
458.	HENRY . HVNTER . OF .	MINIMOOR .	1671

MOUNTMELLICK, QUEEN'S CO.

459.	NATHANIEL . DIER .	MOVNTMELECK .	1664
460.	NATH****** . DIER .	MOVNTMELECK .	1665
461.	RICHARD . WRIGHT . AT .	MOVNTT . MELLECK .	1656
462.	RICHARD . WRIGHT . AT .	MOVNTT . MELLECK .	1659
463.	RICHARD . WRIGHT .	MOVNTMELLECK .	1659
464.	WILLIAM . WILCOCKS .	MOVNTMELICK . SADL^{R}	1670

MOUNTRATH, QUEEN'S CO.

465.	NICHOLAS . RAGGET .	MARCHANT . MOVNTRATH .	

MULLINGAR, CO. WESTMEATH.

466.	THESE . TOKENS . ARE .	FOR . MVLLINGAR .	
467.	ANTHONI . MELAGHLIN .	MVLLINGAR . MAR .	
468.	CHARIS . MELLAGHLIN . OF	MVLLINGAR . HIS . HALPENY .	
469.	CHRISTOPHER .	GILBERT . OF . MVLLINGR .	
470.	CRISTOHER . PETTIT .	MVLINGAR . MARCHA^{T}	1667
471.	IAMES . MELAGHLIN .	OF . MVLLINGAR . MAR .	1655
472.	IAMES . ME******N . OF .	MVLOINGAR . HIS . HALPENY .	
473.	IOHN . DOVGLAS . OF .	MVLINGAR . VINTENER .	1659
474.	THOMAS . G*** . OF .	MVLLINGAR . MAR.	
475.	****** . MVLLENGAR .	HIS . HALFEPENY .	

NAAS, CO. KILDARE.

476. RICHARD . ****AS . OF . NAASE . M*RCH^{T}

NAVAN, CO. MEATH.

477. ANT . CAMDEN . OF . NAVAN . FEARE . GOD . HONER . THE . KING .

NEAGHRUNE, OR NENAGH, CO. TIPPERARY.

478. IOSEPH . LVCAS . OF . NEAGHRVNE . MAR . 1668
479. MAVRICE . THOMAS . OF . NENAGH . 1666
480. ROB . HVTCHINSON . OF . NENAGH . CLEARK . 1658
481. ROB . HVTCHINSON . OF . NENAGH . CLEARK . 1659

NEWCASTLE, CO. LIMERICK.

482. PATRICK . CREAGH . IN . NEWCASTL . MAR .

NEWRY, CO. DOWN.

483. ALEX . HALL . OF . NEWRY . 1668

NEWTOWN, CO. DOWN.

484. IAMES . SMARTTS . OF . NVTOWNE .
485. IAMES . TEMPLETON . IN . NEWTOWNE . HIS . HALF . PENY .

NEWTOWN BAGNAL, CO. CARLOW.

486. WALTER . KARNEY . NEWTOWN . BAGNALL .

NEWTOWN LIMAVADY, CO. LONDONDERRY,

487. IOHN . HILLHOVSE . OF . NEWTOVNLIMAVADY .

NUROUGH. (NEWRY, CO. DOWN?)

488. IOHN . MIDDLETON . OF . THE . NVROVGH .

PHILIPSTOWN, KING'S CO.

489. RICHARD . LAMBERT . OF . PHILLIPSTOWNE . MAR^{T}

PORTAFERRY, CO. DOWN.

490. ROB . BELL . HIS . TOCKEN . IN . PORTFARY . MAR . 1665

PORTARLINGTON, QUEEN'S CO.

491. GEORGE . COPE . OF . PORTARLINGTON . 1673

ROSCOMMON, CO. ROSCOMMON.

492.	VALENTINE . BROWNE .	OF . ROSCOMON . MAR .	

ROSCREA, CO. TIPPERARY.

493.	IOHN . SMITH .	OF . ROSCREA .	

ROSS, CO. WEXFORD.

494.	EDWARD . DAVIS . IN .	ROSS . VINTENER .	
495.	IOHN . OLLIVER . OF .	ROSSE . MERCHANT .	—68
496.	RICHARD . DELAHYD .	IN . ROSSE . MARCHANT .	
497.	(R.S.) THE . DILIGENT . HAND .	MAKETH . RICH . ROS .	1673

SLIGO, CO. SLIGO.

498.	ARCHIBOLD . CVNINGHAM .	MERCH^{T}. IN . SLIGO .	1678
499.	IOHN . CONINGHAME .	MERCH^{T} . IN . SLIGO .	
500.	*** . HVNTER . OF .	SLIGO . MARCHAN .	

TANDERAGEE, CO. ARMAGH.

501.	IOHN . RICHARDSON . OF . TANROGEE .	QVARTER . MASTER .	

THURLES, CO. TIPPERARY.

502.	RICHARD . PVRSELL .	OF . THVRLES .	
503.	THOMAS . FITZ . GERALD .	OF . THVRLES .	1657

TIPPERARY, CO. TIPPERARY.

504.	(R . C.) TEPERARY . WILL .	CHANGE . THEM . AGAN .	

TOOME, CO. ANTRIM.

505.	RICH . BODKIN . OF . TOOME .	FOR . FERRY . FORGE . AND . FISH . ***** .	

TRIM, CO. MEATH.

506.	GEORGE . HARRIS .	IN . TRIM . DIER .	1663
507.	IAMES . KELLYE .	IN . TRYM . MARCH^{T}	
508.	IAMES . KELLYE .	IN . TRYM . MARCHAN .	
509.	PATHRICK . HELOND .	OF . TRYME . MARCH .	
510.	PATRICK . CLINTON .	IN . TRYM . MARCH .	

TUAM, CO. GALWAY.

511.	IAMES . TRESSY . OF .	TVVM . MARCHANT .	

TULLAMORE, KING'S CO.

512.	ROBERT . WORRELL .	IN . TVLLAMOORE .	—70

TULLOW, CO. CARLOW.

513.	RICH . BVRCHALL .	OF . TVLLOWE .	

WATERFORD, CO. WATERFORD.

514.	WATERFORDS . SAFETY . WISHED .	PROCEED . AND . PROSPER .	1659
515.	CORPORATION . OF .	WATERFORD .	1668
516.	ANDREW . RICKARDS . MAYOR .	CITY . OF . WATERFORD .	1658
517.	DAVID . OWEN .	OF . WATERFORD .	—71
518.	EDMAND . RVSSELL .	OF . VVATERFORD .	—73
519.	EDMAND . RVSSELL .	OF . WATERFORD .	—73
520.	IOHN . HEAVEN .	OF . WATERFORD .	1656
521.	IOHN . T*** . OF . THE .	CITTY . OF . WATERFORD .	1667
522.	MARY . STEPHENS . OF .	THE . CITTY . OF . WATERFORD .	16**
523.	PE . CRANISBROVGH .	OF . WATERFORDE .	1671
524.	PEE . CRANISBROVGH .	OF . WATERFORDE .	1671
525.	THO . EXTON . IN .	WATERFORD . VINTNER .	
526.	THOMAS . NOBLE . MERCH^{T}	**** . OF . WATERFORD .	1656
527.	ZACH . CLAYTON .	OF . WATERFORD .	—68

WEXFORD, CO. WEXFORD.

528.	CHARLES . HVDDLE . OF .	WAXFORD . IN . IRELAND .	
529.	CONSTANTINE . NEAL .	OF . WAXFORD . MARCHANT .	
530.	EDWARD . VALE .	OF . WAXFORD .	
531.	FRANCIS . HARVEY . OF . WAXFORD .	WHEN . YOV . PLEASE . ILE . CHANGE . THES .	
532.	GEORG . LININGTON .	OF . WAXFORD . MERCER .	
533.	IOHN . ILLINGWORTH .	WEXFORD . CLOTHGER .	1657
534.	MICHAEL . KEARNEY . OF .	WEXFORD . DISTILLER .	
535.	PAVL . ALFERI .	WEXFORD . CORDWINDER .	1665
536.	THOMAS . IONES .	OF . WEXFORD .	
537.	THOMAS . LOW .	OF . WEXFORD .	1656
538.	WILLIAM . LOVELL .	OF . WAXFORD .	

WICKLOW, CO. WICKLOW.

539.	EDW . HARTSHO**** .	OF . WICKLOW . MARCHN .	—58

YOUGHALL, CO. CORK.

540.	THE . ARMS . OF . YOVGHALL .	IF . NOT . LIKED . I'LL . CHANG . THEM .	1658
541.	ANDREW . WANDRIK .	IN . YOGHILL .	1656
542.	EDWARD . PERRY .	OF . YOVGHALL . **** .	
543.	EDWARD . PERRY .	OF . YOVGHALL .	1667
544.	FLORENCE . GILES . OF .	THE . TOWNE . OF . YAHALL .	
545.	IOHN . GERALD . OF .	YOVGHALL .	1667
546.	IOHN . HANCOCKE .	OF . YOVGHALL . MARCHANT .	1666
547.	IOHN . LVTHER . OF .	YOVGHALL . MERCHANT .	1672
548.	IOHN . MERRICK .	OF . YOVGHALL .	
549.	THOMAS . IONES .	IN . YOVGHALL .	
550.	THOMAS . VAVGHAN .	OF . YOVGHALL .	
551.	THOMAS . WALTERS .	MERCHANT . OF . YOVGHAL .	
552.	Y . T . (*Youghall Town.*)	*A Ship.* (*A square piece.*)	1646

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APPENDIX.

FARTHING TOKENS ISSUED IN IRELAND
FROM 1832 TO 1847.

BELFAST, CO. ANTRIM.

1.	IOHN . ARNOTT . & . C^{O} . SILK . MERCERS . HABERDASHERS . &c.	ONE . FARTHING . PAYABLE . AT . N^{O} . * . 7 . & . 9 . BRIDGE . S^{T} . BELFAST .
2.	FERRAR . & . TAGGART . SILK . MERCERS . HABERDASHERS . &c.	ONE . FARTHING . PAYABLE . AT . DONEGALL . PLACE .
3.	FERRAR . & . COMP^{Y} . SILK . MERCERS . HABERDASHERS . &c.	ONE . FARTHING . PAYABLE . AT . DONEGALL . PLACE .

BELFAST AND CORK.

4.	JOHN . ARNOTT . & . C^{O} . SILK . MERCERS . DRAPERS . &c.	ONE . FARTHING . PAYABLE . IN . BELFAST . & . CORK .

CLONMEL, CO. TIPPERARY.

5.	ONE . FARTHING . *In the field a scissors and measuring stick.*	PAYABLE . AT . M^{c}SWINEY . O'BRIEN . & . C^{O} . VICTORIA . HOUSE . ABBEY . S^{T} . CLONMEL .

CLOYNE, CO. CORK.

6.	R . SWANTON . WOOLLEN . DRAPER . & . HATTER . CLOYNE .	*Same as the obverse.*

CORK, CO. CORK.

7.	CORK . MONT . DE . PIÉTÉ . TOKEN .	*The Arms of Cork.*
8.	ONE . FARTHING . PAYABLE . AT . GEO . S . BEALE'S . GROCERY . WAREHOUSE . 14 . PATRICK . S^{T} . CORK . *In the field a Unicorn's head.*	NEWPORT . COAL . STORES . FISH . S^{T} . CORK . 1842 . *In the field a ship discharging coals.*
9.	ONE . FARTHING . PAYABLE . AT . GEO . S . BEALE'S . GROCERY . WAREHOUSE . 82 . PATRICK . S^{T} . CORK . *In the field a Unicorn's head.*	NEWPORT . COAL . STORES . FISH . S^{T} . CORK . 1842 . *In the field a ship discharging coals.*
10.	J . C . & . C^{O} . LATE . TODD . & . C^{O} . CORK .	ONE . FOURTH . OF . A . PENNY . PAYABLE . IN . CORK . 1841 .
11.	E . CLEBURNE . CLOTHIER . N^{O} . 9 . GR^{T} . GEORGE . S^{T} . CORK .	E . CLEBURNE . WOOLLEN . DRAPER . N^{O} . 9 . GR^{T} . GEORGE . S^{T} . CORK .
12.	WILLIAM . FITZ . GIBBON . AND . C^{O} . MERCHANTS . CORK .	*Same as the obverse.*
13.	W^{M} . FITZ . GIBBON . & . C^{O} . GENERAL . WOOLLEN . LINEN . & . SILK . MERCH^{TS} . G^{T} . GEORGE . S^{T} . CORK . 1835 .	ONE . FARTHING . PAYABLE . AT . WM . FITZGIBBON . & . C^{O} . GT . GEO . S^{T} . CORK .
14.	DENIS . HEGARTY . SPIRIT . DEALER . 15 . BARRICK . S^{T} . CORK.	*Same as the obverse.*

15. JOSEPH . HELEN . CORK . *In the field a shamrock.*	ONE . FARTHING . TOKEN .
16. LYONS . & . C^{O}. TEA . COFFEE . & . SVGAR . IMPORTERS . & . DEALERS . CORK .	*Same as the obverse.*
17. E . D . MAHONY . 62 . NORTH . MAIN . S^{T}. CORK .	TRIMMING . WORSTED . & . COTTON . WAREHOUSE . AND . WOOL . STORE .
18. JOHN . O'DONOGHUES . GENERAL . WAREHOUSE . CORK .	49 . GREAT . GEORGE'S . STREET . CORK .
19. OGILVIE . AND . BIRD . CORK . ONE . FARTHING . 1838 .	PAYABLE . AT . 48 . & . 49 . PATRICK . S^{T}. DRAPERS . AND . SILK . MERCERS .
20. W^{M}. SEYMOUR . & . C^{O}. HARDWARE . MERCHANTS . PATRICK . S^{T}. CORK .	*Vulcan leaning on a sledge which rests on an anvil block.*
21. AMBROSE . SHEPPARD . LEATHER . DEALER . 82 . SHANDON . S^{T}. CORK .	LEATHER . DEALER . AND . SHOE . FINDINGS . WAREHOUSE .

CORK AND BELFAST.

22. J . ARNOTT . & . C^{O}. SILK . MERCERS . DRAPERS . &c.	ONE . FARTHING . PAYABLE . IN . CORK . & . BELFAST .

COVE, CO. CORK.

23. *The Queen's Head.*	SWANTON . & . CO . DRAPERS . COVE .

DUBLIN, CO. DUBLIN.

24. CANNOCK . WHITE . & . C^{O}. 14 . HENRY . S^{T}. DUBLIN . *The Queen's Head.*	CANNOCK . WHITE . & . C^{O}. DRAPERS . 14 . HENRY . S^{T}. DUBLIN . N^{R}. THE . POST . OFFICE .
25. THOMPSON . & . C^{O}. N^{O}. 49 . SOUTH . KING . S^{T}. DUBLIN .	THE . PORTER . BARM . BAKERY . N^{O}. 49 . SOUTH . KING . STREET . DUBLIN .
26. CORK . BAKERY . N^{O}. 49 . SOUTH . KING . ST . DUBLIN .	THE . PORTER . BARM . BAKERY . N^{O}. 49 . SOUTH . KING . STREET . DUBLIN .

27.	CORK . BAKERY . SOUTH . KING . S^{T}. DUBLIN .	THE . PORTER . BARM . BAK 28 . STEPHENS . GREEN . N DUBLIN .

DUBLIN AND CORK.

28.	CANNOCK . WHITE . & . C^{o}. DUBLIN . & . CORK . *The Queen's Head.*	CANNOCK . WHITE . & . C^{o}. DR 14 . HENRY . S^{T}. DUBLIN THE . POST . OFFICE .

DUBLIN, CORK, OR LIMERICK.

29.	TODD . BURNS . & . C^{o}. DRAPERS . MARY . S^{T}. DUBLIN . 1834 . ONE . FARTHING .	W . TODD . & . C^{o}. DRAPERS . & . LIMERICK . PAYABL DUBLIN . CORK . OR . LIME

GALWAY, CO. GALWAY.

30.	GEO^{E}. FARQUARSON . & . C^{o}. WOOLLEN . DRAPERS . GALWAY .	GEORGE . FARQUARSON . & . C^{o} WAY . 1839 .

KILLARNEY, CO. KERRY.

31.	WILLIAM . M^{c}SWEENY . MERCHANT . KILLARNEY .	COMMERCIAL . WAREHOUSE . 1 . HENN . S^{T}. *The Queen's*
32.	M^{c}SWEENY . & . O'KEEFFE . LATE I . WELPLY . & . C^{o}. GENERAL DRAPERS .	COMMERCIAL . HOUSE . KILLA *The Queen's Head.*
33.	M^{c}SWEENY . & . O'KIEFFE . LATE I. WELPLY . & . C^{o}. GENERAL DRAPERS .	COMMERCIAL . HOUSE . N^{o}. 1 . HENN . ST^{T}. KILLARNEY .
34.	SWEENY . & . O'KEEFE . GENERAL . DRAPERS . &c . KILLARNEY .	COMMERCIAL . HOUSE . 1 . HENN . STREET . KILLARNE
35.	C . A . O'KEEFFE . MAIN . ST . KILLARNEY . *The Queen's Head.*	WOOLLEN . & . LINEN . DR HATTER . & . HOSIER .

LIMERICK, CO. LIMERICK.

36.	PAYABLE . AT . THE . MONT . DE . PIÉTÉ . LIMERICK . 1837 . *The Mont de Piété .*	ONE . FARTHING . *within an wreath.*

37.	LESLIE . ACHESON . WOOLLEN . DRAPER . LIMERICK .	1838 . *within a shamrock wreath.*
38.	JOHN . EGAN . WHOLESALE . MANCHESTER . WAREHOUSE . PAYABLE . AT . N^{O}. 6 . ROBERT . STREET . LIMERICK .	ONE . FARTHING . 1832 . *In the field a spinning-wheel.*
39.	CHA^{S}. HIGGINSON . & . C^{O}. DRAPERS . LIMERICK .	*The Queen's Head.*
40.	M^{C}ARDELL . AND . BOURKE . GUNPOWDER . MERCHANTS . LIMERICK . 1843 .	TRIMMING . WORSTED . & . STATIONARY . WAREHOUSE . 3 . RUTLAND . S^{T}.
41.	REVINGTON . HIGGINSON . & . C^{O}. DRAPERS . LIMERICK .	1846. *The Queen's Head.*
42.	PAYABLE . AT . IN^{O}. UNTHANK . & . SON'S . 34 . WILLIAM . STREET. LIMERICK .	SOURCES . OF . A . NATION'S . WEALTH . *In the field a weaver's shuttle and a plough.*

MACROOM, CO. CORK.

43.	JAMES . WELPLY . MERCHANT . MACROOM . 1845 .	VICTORIA . HOUSE . MACROOM . *The Queen's Head.*
44.	JAMES . WELPLY . MERCHANT . MACROOM .	*Same as the obverse.*

MALLOW, CO. CORK.

45.	ROBERT . EVANS . AND . COMPANY . MALLOW . 1847 .	WOOLLEN . DRAPERS . SILK . MERCERS . AND . HATTERS .

MITCHELSTOWN, CO. CORK.

46.	DENNIS . MAHONY . LINEN . & . WOOLLEN . DRAPER . MITCHELSTOWN .	LINEN . & . WOOLLEN . DRAPER . MITCHELSTOWN . *In the field a sheep suspended in a sling.*

SKIBBEREEN, CO. CORK.

47.	GEORGE . JAMES . LEVIS . GENERAL . COMMISSION . MERCHANT . SKIBBEREEN .	ONE . FARTHING . TOKEN .
48.	SAMUEL . VICKERY . BAKER . SKIBBEREEN .	FULL . WEIGHT . *In the field a balance, in one scale of which is a loaf.*

TIPPERARY, CO. TIPPERARY.

49.	ONE . FARTHING . PAYABLE . AT . MORRIS'S . COMMERCIAL . HOUSE . TIPPERARY .	PAYABLE . AT . MORRIS'S . COMMERCIAL . HOUSE . TIPPERARY .

TRALEE, CO. KERRY.

50.	J . HANRAHAN . & . C^{O}. VICTORIA . HOUSE . TRALEE .	WOOLLEN . & . LINEN . DRAPERS . HATS .
51.	J . LUMSDEN . & . C^{O}. HATTERS . TRALEE .	DRAPERS . AND . SILKMERCERS . 33 . DENNY . STREET .
52.	LUMSDEN . ORR . & . C^{O}. TRALEE . ONE . FARTHING . 1839 .	DRAPERS . AND . SILKMERCERS . PAYABLE . AT . 33 . DENNY . S^{T}.
53.	M . H . REARDON . TRALEE . ONE . FARTHING . 1839 .	WOLLEN . LINEN . & . HAT . WAREHOUSE . PAYABLE . AT . TRALEE .

WATERFORD, CO. WATERFORD.

54.	CONWAY . CARLETON . DRAPER . WATERFORD .	1841 . *within a shamrock wreath.*
55.	JAMES . CARROLL . SILK . MERCER . DRAPER . &c . QUAY . WATERFORD .	ONE . FARTHING . PAYABLE . AT . THE . COMMERCIAL . HOUSE . QUAY . WATERFORD .
56.	J . W . DELAHUNTY . DRAPER . AND . HATTER . WATERFORD .	*The Queen's Head.*
57.	DAVID . HOLDEN . WOOLLEN . DRAPER . 1 . BROAD . S^{T}. WATERFORD .	ESTABLISHED . 1835 . (THE . NEW . CLOTH . HALL) . *on a bale of goods.*
58.	W . KIRKWOOD . DRAPER . & . SILK . MERCER . WATERFORD .	*Front view of Kirkwood's house.*
59.	M^{c}LEER . & . KELLY . DRAPERS .	NATIONAL . WOOLLEN . HOUSE . QUAY . WATERFORD .
60.	MILLING . & . COMPANY . 4 . LITTLE . GEORGES . STREET . WATERFORD .	SILK . MERCERS . LINEN . DRAPERS . HABERDASHERS . &c . (M . & . C^{O}) *on a bale of goods.*
61.	WALSHE . ROBERTSON . & . CO . DRAPERS . 1846 .	WALSHE . ROBERTSON . & . C^{O}. 74 . MERCHANTS . QUAY . WATERFORD .

62.	W^{M}. FOSTER . LINEN . DRAPER . & . HABERDASHER .	*Same as the obverse.*

No. V.

ACCOUNT

OF THE

ROYAL IRISH ACADEMY,

FROM 1st APRIL, 1848, TO 31st MARCH, 1849.

THE CHARGE.

	£	s.	d.	£	s.	d.
To Balance in favour of the Public on 1st April, 1848,	. . . .			45	8	1
Parliamentary Grant for 1848 (paid 9th September, 1848),	300	0	0			
Quarterly Warrants from Treasury,	146	17	8			
Total from Treasury,				446	17	8
Interest on Stock:						
One year's, on £1643 19 6, 3¼ per Cent.	53	8	7			
Ditto, ,, 867 1 10, 3 ,,	26	0	3			
Total Interest on Stock,				79	8	10
Rent of Stable, due 1st November, 1848,	21	0	0			
Deduct proportion of Poor Rate,	1	1	0			
				19	19	0
Publications Sold:						
Transactions and Proceedings sold,	12	11	3			
Ditto, sold by Messrs. Boone, London,	6	10	0			
Total amount of Books sold,				19	1	3
Life Compositions:						
Rev. William Graham,	15	15	0			
E. Davy, M. D.,	6	6	0			
John Purser, Esq.,	21	0	0			
Forward,	43	1	0	610	14	10

	£	s.	d.	£	s.	d.
Brought forward,	43	1	0	610	14	10
Jonathan Pim, Esq.,	21	0	0			
William Ogilby, Esq.,	15	15	0			
Alexander Halliday, Esq.,	21	0	0			
Hon. Justice Crampton,	6	6	0			
W. F. Montgomery, M. D.,	6	6	0			
James Apjohn, M. D.,	6	6	0			
Andrew Graham, Esq.,	21	0	0			
Total Life Compositions,				140	14	0
Entrance Fees:						
Rev. William Graham,	5	5	0			
William Armstrong, Esq.,	5	5	0			
Michael Barry, Esq.,	5	5	0			
Major W. D. E. Broughton, R. E.,	5	5	0			
Andrew Graham, Esq.,	5	5	0			
J. C. Kenny, Esq.,	5	5	0			
Rev. J. J. Fitzgerald,	5	5	0			
Rev. E. Dillon,	5	5	0			
John Carley, Esq.,	5	5	0			
John Bell, Esq.,	5	5	0			
Henry Smyth, Esq.,	5	5	0			
John Purser, Esq.,	5	5	0			
Rev. James Bewglass,	5	5	0			
Viscount Dungannon,	5	5	0			
Maurice Collis, Esq.,	5	5	0			
Rev. John Magrath,	5	5	0			
Jonathan Pim, Esq.,	5	5	0			
William Ogilby, Esq.,	5	5	0			
James Hartley, Esq.,	5	5	0			
John L. Rickards, Esq.,	5	5	0			
Total Entrance Fees,				105	0	0
Annual Subscriptions:						
Edward Hutton, M. D., ... 1848,	2	2	0			
Rev. Dr. West, ... ,,	2	2	0			
James Talbot, Esq., ... ,,	2	2	0			
Edward Barnes, Esq. . . . . . ,,	2	2	0			
Charles Bournes, Esq., ... ,,	2	2	0			
Francis L'Estrange, Esq., ... ,,	2	2	0			
C. T. Webber, Esq., ... ,,	2	2	0			
Fleetwood Churchill, M. D., ... ,,	2	2	0			
Henry Clare, Esq., ... ,,	2	2	0			
W. T. Mulvany, Esq., ... ,,	2	2	0			
Forward,	21	0	0	856	8	10

		£	s.	d.	£	s.	d.
Brought forward,		21	0	0	856	8	10
Rev. H. F. C. Logan,	1848,	2	2	0			
Robert Adams, Esq.,	„	2	2	0			
Wyndham Goold, Esq.,	„	2	2	0			
William Hogan, Esq.,	„	2	2	0			
John Hamilton, Esq.,	„	2	2	0			
F. M. Jennings, Esq.,	„	2	2	0			
R. R. Madden, M. D.,	„	2	2	0			
J. Huband Smith, Esq.,	„	2	2	0			
W. B. Wallace, Esq.,	„	2	2	0			
George Yeates, Esq.,	„	2	2	0			
Thomas Cather, Esq.,	„	2	2	0			
Alexander Ferrier, Esq.,	„	2	2	0			
Charles Hanlon, Esq.,	„	2	2	0			
John Mollan, M. D.,	„	2	2	0			
Hon. F. Ponsonby,	„	2	2	0			
William Lefanu, Esq.,	„	2	2	0			
James Magee, Esq.,	„	2	2	0			
W. A. Wallace, Esq.,	„	2	2	0			
Hon. and Rev. William Wingfield,	1847,	2	2	0			
Ditto,	1848,	2	2	0			
Rev. James Reid,	„	2	2	0			
J. B. Kennedy, Esq.,	„	2	2	0			
W. R. Townsend, Esq.,	„	2	2	0			
John Tyrrell, Esq.,	„	2	2	0			
William Henn, Esq.,	„	2	2	0			
D. P. Starkey, Esq.,	„	2	2	0			
George Carr, Esq.,	„	2	2	0			
Charles Vignoles, Esq.,	„	2	2	0			
Mountifort Longfield, Esq.,	„	2	2	0			
John Aldridge, M. D.,	„	2	2	0			
John M'Mullen, Esq.,	„	2	2	0			
Philip Jones, Esq.,	„	2	2	0			
Lord Farnham,	„	2	2	0			
Rev. Francis Crawford,	„	2	2	0			
William Longfield, Esq.,	„	2	2	0			
James S. M'Donnell, Esq.,	„	2	2	0			
Sir Edward Borough, Bart.,	„	2	2	0			
C. W. Williams, Esq.,	„	2	2	0			
Robert Cully, Esq.,	„	2	2	0			
F. Barker, M. D.,	„	2	2	0			
James S. Close, Esq.,	„	2	2	0			
John Davidson, Esq.,	„	2	2	0			
John Hart, M. D.,	„	2	2	0			
Hon. James King,	„	2	2	0			
James Patten, M. D.,	„	2	2	0			
Brought forward,		115	10	0	856	8	10

		£	s.	d.	£	s.	d.
Brought forward,		115	10	0	856	8	10
John O'Donovan, Esq.,	1848,	2	2	0			
Rev. R. M'Ghee,	,,	2	2	0			
Right Hon. the Lord Chancellor,	,,	2	2	0			
Captain H. James,	,,	2	2	0			
Robert Law, M. D.,	,,	2	2	0			
His Grace the Archbishop of Dublin,	,,	2	2	0			
J. K. Ingram, Esq.,	,,	2	2	0			
C. C. King, M. D.,	,,	2	2	0			
Thomas Butler, Esq.,	,,	2	2	0			
A. T. Preston, Esq.,	,,	2	2	0			
William M'Dougall, Esq.,	,,	2	2	0			
W. T. Lloyd, Esq.,	,,	2	2	0			
R. Deasy, Esq.,	,,	2	2	0			
Aquilla Smith, M. D.,	,,	2	2	0			
C. W. Hamilton, Esq.,	,,	2	2	0			
James Apjohn, M. D.,	,,	2	2	0			
G. A. Hamilton, Esq., M. P.,	,,	2	2	0			
Rev. John Connell,	,,	2	2	0			
Robert Mallett, Esq.,	,,	2	2	0			
Rev. James Wills,	,,	2	2	0			
Earl of Enniskillen,	,,	2	2	0			
William Gregory, M. D.,	,,	2	2	0			
John Wynne, Esq.,	,,	2	2	0			
H. C. Beauchamp, M. D.,	,,	2	2	0			
John Alcorn, Esq.,	,,	2	2	0			
Rev. William Lee,	,,	2	2	0			
W. E. Hudson, Esq.,	,,	2	2	0			
Earl of Dunraven,	,,	2	2	0			
John Finlay, Esq.,	,,	2	2	0			
Sir Lucius O'Brien, Bart.,	,,	2	2	0			
Sir John Kingston James, Bart.,	,,	2	2	0			
T. J. Tuffnell, M. D.	,,	2	2	0			
Thomas Oldham, Esq.,	,,	2	2	0			
Adolphus Cooke, Esq.,	,,	2	2	0			
Ditto,	1849,	2	2	0			
Ditto,	1850,	2	2	0			
E. J. Cooper, Esq.,	1848,	2	2	0			
Rev. S. Haughton,	,,	2	2	0			
David Moore, Esq.,	,,	2	2	0			
W. N. Hancock, Esq.,	,,	2	2	0			
J. M. Berry, Esq.,	,,	2	2	0			
Thomas Grubb, Esq.,	,,	2	2	0			
Pierce Morton, Esq.,	,,	2	2	0			
Rev. C. Porter,	,,	2	2	0			
T. F. Kelly, LL. D.,	,,	2	2	0			
Forward,		210	0	0	856	8	10

		£	s.	d.	£	s.	d.
Brought forward,		210	0	0	856	8	10
George Lefroy, Esq.,	1848,	2	2	0			
S. O'Meagher, Esq.,	,,	2	2	0			
J. S. Eiffe, Esq.,	,,	2	2	0			
Edward Bewley, M. D.	,,	2	2	0			
E. S. Clarke, M. D.,	,,	2	2	0			
William Murray, Esq.,	,,	2	2	0			
Rev. George Longfield,	,,	2	2	0			
Jonathan Osborne, M. D.,	,,	2	2	0			
T. J. Beasly, Esq.,	,,	2	2	0			
M. O. R. Dease, Esq.,	,,	2	2	0			
Rev. I. G. Abeltshauser,	,,	2	2	0			
Right Hon. D. R. Pigott, Chief Baron,	,,	2	2	0			
Rev. N. J. Halpin,	,,	2	2	0			
Rev. J. A. Galbraith,	,,	2	2	0			
W. Grimshaw, M. D.,	,,	2	2	0			
J. M. Neligan, M. D.,	,,	2	2	0			
M. H. Stapleton, M. B.,	,,	2	2	0			
J. T. Evans, M. D.,	,,	2	2	0			
T. N. Redington, Esq.,	,,	2	2	0			
Samson Carter, Esq.,	,,	2	2	0			
William Blacker, Esq.,	,,	2	2	0			
R. C. Walker, Esq.,	,,	2	2	0			
Rev. William Roberts,	,,	2	2	0			
M. R. Sausse, Esq.,	,,	2	2	0			
Philip Bevan, M. D.,	,,	2	2	0			
R. J. Graves, M. D.,	,,	2	2	0			
Sir M. Barrington, Bart.,	,,	2	2	0			
H. H. Joy, Esq.,	,,	2	2	0			
D. Dunlop, Esq.,	,,	2	2	0			
James Claridge, Esq.,	,,	2	2	0			
William Stokes, M. D.	,,	2	2	0			
G. A. Kennedy, M. D.,	,,	2	2	0			
O. Sproule, Esq.,	,,	2	2	0			
W. C. Dobbs, Esq.,	,,	2	2	0			
William Andrews, Esq.,	,,	2	2	0			
Rev. Dr. Marks,	,,	2	2	0			
W. J. O'Driscoll, Esq.,	,,	2	2	0			
William Barker, M. D.,	,,	2	2	0			
Arthur Jacob, M. D.	,,	2	2	0			
Jacob Owen, Esq.,	,,	2	2	0			
J. F. Waller, Esq.,	,,	2	2	0			
Sir Thomas Staples, Bart.,	,,	2	2	0			
P. D. Hardy, Esq.,	,,	2	2	0			
P. J. Blake, Esq.,	,,	2	2	0			
Rev. J. H. Jellett,	,,	2	2	0			
Forward,		304	10	0	856	8	10

		£	s.	d.	£	s.	d.
Brought forward,		304	10	0	856	8	10
D. J. Corrigan, M. D.,	.1849,	2	2	0			
Robert Reid, M. D.,	.1848,	2	2	0			
C. P. M'Donnell, Esq.,	,,	2	2	0			
R. W. Smith, Esq.,	,,	2	2	0			
G. A. Fraser, Esq.,	,,	2	2	0			
The Very Rev. James Gregory, Dean of Kildare,	,,	2	2	0			
B. P. Wilme, Esq.,	,,	2	2	0			
Edmond Getty, Esq.,	,,	2	2	0			
W. Monsell, Esq.,	,,	2	2	0			
Charles Vignoles, Esq.,	.1849,	2	2	0			
Richard Sharp, Esq.,	.1848,	2	2	0			
H. W. Massy, Esq.,	,,	2	2	0			
B. J. Chapman, Esq.,	,,	2	2	0			
Ditto,	.1849,	2	2	0			
J. D'Alton, Esq.,	.1848,	2	2	0			
Robert Tighe, Esq.,	.1849,	2	2	0			
John Anster, LL.D.,	.1848,	2	2	0			
T. E. Beatty, M. D.,	,,	2	2	0			
Samuel Ferguson, Esq.,	,,	2	2	0			
R. C. Williams, M. D.,	,,	2	2	0			
R. J. Graves, M. D.,	.1849,	2	2	0			
Robert Franks, Esq.,	,,	2	2	0			
A. B. Cane, Esq.,	,,	2	2	0			
W. T. Kent, Esq.,	.1848,	2	2	0			
Rev. Thomas Stack,	,,	2	2	0			
Richard Cane, Esq.,	.1849,	2	2	0			
Michael Donovan, Esq.,	,,	2	2	0			
John Burrowes, Esq.,	,,	2	2	0			
F. L'Estrange, M. D.,	,,	2	2	0			
A. W. Baker, Esq.,	.1848,	2	2	0			
A. W. Baker, Junior, Esq.,	,,	2	2	0			
William Brooke, Esq.,	.1849,	2	2	0			
M. M. O'Grady, M. D.,	,,	2	2	0			
J. C. Kenny, Esq.,	,,	2	2	0			
Hon. James King,	,,	2	2	0			
Rev. James Reid,	,,	2	2	0			
William Stokes, M. D.,	,,	2	2	0			
William F. Montromery, M. D.,	.1848,	2	2	0			
William Hogan, Esq.,	,,	2	2	0			
William Henn, Esq.,	.1849,	2	2	0			
The Very Rev. Richard Butler, Dean of Clonmacnoise,	,,	2	2	0			
George Carr, Esq.,	,,	2	2	0			
J. C. Egan, M. D.,	,,	2	2	0			
Forward,		394	16	0	856	8	10

		£	s.	d.	£	s.	d.
Brought forward,		394	16	0	856	8	10
Major W. E. D. Broughton, R. E.,	1849,	2	2	0			
George Cash, Esq.,	1848,	2	2	0			
Robert Law, M. D.,	1849,	2	2	0			
E. Cane, Esq.,	„	2	2	0			
F. W. Burton, Esq.,	„	2	2	0			
Marmion Savage, Esq.,	1848,	2	2	0			
J. Grene, Esq.,	1849,	2	2	0			
Rev. Dr. West,	„	2	2	0			
J. B. Kennedy, Esq.,	„	2	2	0			
C. W. Hamilton, Esq.,	„	2	2	0			
Sir M. Chapman, Bart.,	„	2	2	0			
Lord Farnham,	„	2	2	0			
W. T. Mulvany, Esq.,	„	2	2	0			
James Talbot, Esq.,	„	2	2	0			
James Hartley, Esq.,	„	2	2	0			
Henry Freke, M. D.,	„	2	2	0			
Alexander Ferrier, Jun., Esq.,	„	2	2	0			
William Edington, Esq.,	„	2	2	0			
Dean of St. Patrick's,	„	2	2	0			
John M'Mullen, Esq.,	„	2	2	0			
Sir R. Morison,	„	2	2	0			
Charles Doyne, Esq.,	„	2	2	0			
F. J. Sidney, Esq.,	„	2	2	0			
Earl of Dunraven,	„	2	2	0			
W. E. Hudson, Esq.,	„	2	2	0			
C. C. King, M. D.,	„	2	2	0			
John Wynne, Esq.,	„	2	2	0			
Thomas Butler, Esq.,	„	2	2	0			
Edward Hutton, M. D.,	„	2	2	0			
William Drennan, Esq.,	„	2	2	0			
Right Hon. the Lord Chancellor,	„	2	2	0			
G. Fitzgibbon, Esq.,	„	2	2	0			
Wyndham Goold, Esq.,	„	2	2	0			
Captain Henry James,	„	2	2	0			
Edward Barnes, Esq.,	„	2	2	0			
John Mollan, M. D.,	„	2	2	0			
F. M. Jennings, Esq.,	„	2	2	0			
Sir M. Barrington, Bart.,	„	2	2	0			
Total Annual Subscription,					474	12	0
SUBSCRIPTIONS FOR EXCAVATIONS AT DOWTH TUMULUS:							
Charles Bournes, Esq.,		0	10	0			
Captain T. A. Larcom, R. E.,		5	0	0			
Right Hon. Sir Thomas Esmonde, Bart.,		1	0	0			
Forward,		6	10	0	1331	0	10

	£	s.	d.	£	s.	d.
Brought forward,	6	10	0	1331	0	10
G. A. Hamilton, Esq., M. P., ...	5	0	0			
William Henn, Esq., ...	1	0	0			
Robert Callwell, Esq., ...	1	2	0			
Sir William Betham, ...	0	10	0			
Total Amount of Subscriptions to Dowth, Tumulus, ...				14	2	0
SUBSCRIPTION FOR THE PURCHASE OF DOMNACH AIRGID:						
William M'Dougall, Esq., ...	1	0	0			
Total for purchase of Domnach Airgid, .				1	0	0
SUBSCRIPTIONS FOR THE PURCHASE OF SIR WILLIAM BETHAM'S IRISH MANUSCRIPTS.						
John Burrowes, Esq., ...	1	0	0			
C. T. Webber, Esq., ...	1	0	0			
Jacob Owen, Esq., ...	1	0	0			
M. O. R. Dease, Esq., ...	1	0	0			
Rev. James Wilson, ...	1	1	0			
George L. Conyngham, Esq., ...	1	0	0			
N. P. O'Gorman, Esq., ...	2	0	0			
G. W. Hemans, Esq., ...	2	2	0			
Rev. H. Lloyd, D. D., ...	25	0	0			
Rev. Charles Mayne, ...	1	0	0			
Hon. Justice Crampton, ...	10	0	0			
Ven. Archdeacon Strong, ...	2	0	0			
P. R. Webb, Esq., ...	0	10	0			
Rev. H. B. Knox, ...	1	0	0			
Marquis of Kildare, ...	10	0	0			
J. T. Gilbert, Esq., ...	1	0	0			
Lieut.-Col. Portlock, ...	1	0	0			
Thomas Fortescue, Esq., ...	5	0	0			
Thomas Hutton, Esq., ...	3	0	0			
Lord Bishop of Cork, ...	3	3	0			
M. Donovan, Esq., ...	1	1	0			
Robert Ball, Esq., ...	5	0	0			
Rev. J. H. Todd, D. D., ...	21	0	0			
Rev. Charles Graves, A. M., ...	21	0	0			
Rev. W. H. Drummond, D. D., ...	2	0	0			
George Smith, Esq., ...	5	0	0			
J. C. Kenny, Esq., ...	2	0	0			
William Henn, Esq., ...	1	0	0			
Major W. E. D. Broughton, R. E., ...	2	2	0			
Alexander Parker, Esq., ...	1	0	0			
Forward,	133	19	0	1346	2	10

	£	s.	d.	£	s.	d.
Brought forward,	133	19	0	1346	2	10
John Grene, Esq., ...	1	0	0			
Rev. William Reeves, ...	1	1	0			
D. H. Kelly, Esq., ...	1	1	0			
Sir M. Chapman, Bart.,.	1	0	0			
Alexander Ferrier, Jun., Esq., ...	1	0	0			
John Mollan, M. D., ...	1	0	0			
F. M. Jennings, Esq., ...	1	0	0			
Total Subscriptions for Purchase of Betham MSS., ...				141	1	0
TOTAL AMOUNT OF CHARGE, ...	. . . .			1487	3	10

THE DISCHARGE.

ANTIQUITIES PURCHASED.	£	s.	d.	£	s.	d.
Campion, J. C. N., spear-head,	3	0	0			
Dolan, Thomas, bronze hatchet,	0	2	6			
Donegan, John, sundry antiquities,	2	15	0			
Glennon, Richard, antiquities,	0	17	0			
Graves, James, silver antique,	4	0	0			
Underwood, James, horn tablets and bone ruler,	0	5	0			
Wakeman, W. F., sundries,	10	0	0			
Waterhouse and Co., gold ring,	1	14	0			
Total antiquities purchased,				22	13	6
BOOKS, PRINTING, AND STATIONERY.						
Bellew, G., paper and books,	2	1	4			
Camden Society, subscription, 1846, 1847, 1848, 30th March, 1849,	3	0	0			
Cranfield, Thomas, paper,	0	16	6			
Grant and Bolton, stamps,	2	3	7			
Gill, M. H., balance of account, printing Proceedings, 6th August, 1849,	175	8	3			
Ditto, printing vol. XXI. Transactions,	269	18	0			
Hanlon, George, woodcuts,	4	10	0			
Hodges and Smith, books, &c.,	27	13	8			
Jones, S. A., four vols. Transactions,	0	6	0			
Jones, J. F., sundries,	4	3	3			
Madden and Hare, paper,	0	5	0			
Marshall, Alexander, Directory,	0	10	6			
Mullen, George, binding,	9	19	8			
Mullen and Son, ditto,	17	6	8			
Peterkin, J., engravings, &c.,	33	4	1			
Ponsonby, E., ruled paper,	0	9	0			
Ray Society, subscription to, one year, due 2nd February, 1849,	1	1	0			
O'Shaughnessy, J. J., printing,	3	13	6			
Tallon, John, envelopes, &c.,	2	19	4			
Taylor, R. and J. E., Part xviii. Memoirs,	2	14	0			
Forward,	562	3	4	22	13	6

	£	s.	d.	£	s.	d.
Brought forward,	562	3	4	22	13	6
Skiffington, Thomas, Irish MSS., ...	0	12	0			
Wiseheart, J., Pencils, ...	0	2	0			
Total Amount of Books, Printing, &c., .				562	17	4
COALS, GAS, ETC.						
Dublin Consumers' Gas Company, coke, . .	2	15	2			
Ditto, gas, ...	12	14	6			
Keegan, J., bogwood, ...	0	15	0			
Oldham, Thomas, bottle wax, ...	0	0	4			
Hoey, James, twenty tons coal, and carriage,	16	2	0			
Spear and Co., wax taper, ...	0	0	6			
Total Amount of Coals, Gas, &c., . . .				32	7	6
REPAIRS OF HOUSE.						
Browne, John, cleaning windows, glazing, painting, &c., to 25th Nov., 1848, . . .	13	18	10			
Bryan, James, cleaning ash-pit, ...	0	5	0			
Casey, Paul, sundry repairs, ...	1	7	5			
Moran, J., sweeping chimneys, ...	0	11	6			
Murphy, James, sweeping chimneys, . . .	0	4	0			
Surman, George, sundry repairs, ...	30	8	3			
Total Repairs of House, ...				46	15	0
RENT, TAXES, AND INSURANCE.						
Symes, Arthur, half year's rent, house, . .	52	4	6			
Acton, William, half year's rent, do., . .	52	4	6			
Globe Insurance Company, insurance, . . .	5	13	6			
National do., do., ...	9	16	0			
Pipe Water Tax, one year, ...	1	19	2			
Minister's Money, one year, ...	2	15	5			
Total Rent, Taxes, and Insurance, . .				124	13	1
FURNITURE AND REPAIRS.						
Browne, John, glass in Museum, ...	1	4	6			
Total Furniture and Repairs, ...				1	4	6
SALARIES, WAGES, ETC.						
Ball, Robert, Esq., Treasurer, ...	21	0	0			
Clibborn, Edward, salary, ...	150	0	0			
Forward,	171	0	0	790	10	11

	£	s.	d.	£	s.	d.
Brought forward,	171	0	0	790	10	11
Curry, A., attending Evening Meetings, . .	2	8	4			
Drummond, Rev. W. H., D. D., librarian, .	21	0	0			
Graves, Rev. Charles, Secretary of Council, .	21	0	0			
Hamilton, William, hall porter, one year, .	34	17	10			
Hamilton, William, and his wife, Christmas allowance, ...	2	2	0			
O'Brien, Thomas, messenger, one year, . .	39	0	0			
Plunket, James, ...	11	13	0			
Todd, Rev. J. H., D. D., Secretary of Academy, ...	21	0	0			
Todhunder, J., Accountant, ...	40	0	0			
Total Salaries, Wages, &c., ...				364	1	2

CUNNINGHAM MEDALS.

	£	s.	d.	£	s.	d.
West and Son, four gold medals, ...	88	0	0			
Total cost of medals, ...				88	0	0

CONTINGENCIES.

	£	s.	d.	£	s.	d.
Boyle, Low, Pim, and Co., commission for receiving dividends, ...	0	5	2			
Boone, T. and W., expenses on parcels, . .	2	17	6			
Clibborn, Edward, allowance for cleaning house, ...	10	0	0			
Hodges, John, and Sons, nails, ...	0	0	5½			
Johnson, T., gum, &c., ...	0	5	4			
Kennan and Son, wire, ...	0	2	1			
Maguire, twine, ...	0	7	1½			
Malone, P., shaking carpets, ...	0	5	0			
Freight, charges, and carriage of sundry packages, ...	5	15	5			
Postages and postage stamps, ...	5	9	10			
Sharp, Richard, winding and regulating clock,	0	15	0			
Tighe, James, engrossing petition to Parliament, ...	1	3	0			
Ball, Robert, Esq., for stamps on Treasury allowance, ...	0	6	0			
Total Contingencies, ...				27	11	11
Total Discharge, ...	. . .		£	1270	4	0
Balance in favour of the Public, . .	. . . .			216	19	10
The Charge, ...	. . .		£	1487	3	10

STATE OF THE BALANCE.

	£	s.	d.
In Bank of Ireland, ...	172	12	6
In Treasurer's hands, ...	44	7	4
	£216	19	10

The Treasurer reports, that there is to the credit of the Academy in the Bank of Ireland, £867 1*s.* 10*d.* in Three per Cent. Consols, and £1643 19*s.* 6*d.* in Three and a quarter per Cent. Government Stock, the latter known as the Cunningham Fund.

(Signed), ROBERT BALL,
Treasurer.

31*st* *March*, 1849.

No. VI.

DAILY OBSERVATIONS ON THE WEATHER,

AND ON

THE RISE AND FALL OF THE SHANNON,

DURING THE YEARS 1846, 1847, AND 1848,

MADE AT ATHLONE.

BY

JOHN LONG, ESQ.

PRESENTED TO THE ACADEMY

BY COLONEL H. D. JONES, R.E.,

CHAIRMAN OF THE BOARD OF WORKS,

DECEMBER 10, 1849.

ABSTRACT

Of accompanying Digests made at Athlone, on the Fall of Rain, Rise and Fall of the Shannon, and Direction of the Wind, during the Years 1845, 1846, 1847, *and* 1848.

YEARS.	RAIN.							RIVER SHANNON.				WIND.							
	Quantity which fell each year.			Greatest Fall in one successive Day and Night.	Number of Days without Rain.	Greatest Number of successive Days		Total Rise and Fall of the Shannon during each Year.				Number of Days in which the Wind was							
								Upper Sill.		Lower Sill.									
	Days.	Nights.	Total.			With Rain.	Without R.	Rise.	Fall.	Rise.	Fall.	North.	North E.	East.	South E.	South.	South W.	West.	North W.
	Inches.	Inches.	Inches.	Inches.	No.	No.	No.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	No.	No.	No.	No.	No.	No.	No.	No.
1845,	14.02	12.97	26.99	1.18	177	9	14	14 11	11 8½	24 4	18 9	60	20	24	47½	52½	31	41	89
1846,	14.87	17.50	32.37	1.45	174	15	12	12 8½	15 0½	19 7	24 0	58	15	15	56	58	47	47	69
1847,	12.85	10.65	23.50	0.89	193	11	8	17 2	14 8	22 11½	21 1½	51	21	22	49	67	39	49	67
1848,	17.66	15.77	33.43	1.11	165	13	14	17 5½	19 0	24 0	27 4	45	27	16	43	67	48	57	63
Amount for four years, ...	59.40	56.89	116.29	1.45	709			62 3	60 5	90 10½	91 2½	214	83	77	195½	244½	165	194	288
Average for one year, ...	14.85	14.22¼	29.07¼		177¼			15 6¾	15 1¼	22 8⅝	22 9⅝	53½	20¾	19¼	48⅞	61⅛	41¼	48½	72

MONTH.	RAIN.							RIVER SHANNON.				WIND.							
	Quantity which fell each Month.			Greatest Fall in one successive Day and Night.	Number of Days without Rain.	Greatest Number of successive Days		Total Rise and Fall of the Shannon during each Month.				Number of Days in which the Wind was							
								Upper Sill.		Lower Sill.									
	Days.	Nights.	Total.			With Rain.	Without R.	Rise.	Fall.	Rise.	Fall.	North.	North E.	East.	South E.	South.	South W.	West.	North W.
	Inches.	Inches.	Inches.	Inches.	No.	No.	No.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	No.	No.	No.	No.	No.	No.	No.	No.
January, . . .	1.74	1.45	3.19	.77	7	9	2	2 9	0 9½	3 11½	0 8	1	. .	1	6½	9½	3	3	7
February, . . .	0.67	0.58	1.25	.27	11	8	4	0 2	1 1	0 5	1 11½	4	. .	1	5	9	1	3	5
March, ...	0.56	0.57	1.13	.21	19	4	14	0 8	1 9	0 11½	2 4½	5	8	2	3	2	3	5	3
April, ...	0.69	0.57	1.26	.48	22	4	11	0 11	1 11	1 3½	1 10½	5	2	4	8	4	1	1	5
May, ...	0.78	0.57	1.35	.48	20	4	9	0 11	0 10	0 6	1 5½	18	2	3	1	. .	1	. .	6
June, ...	1.61	1.37	2.98	1.15	16	4	7	0 11½	1 1½	1 1½	1 8	1	. .	1	3	7	4	2	12
July, ...	2.11	1.47	3.58	.93	12	7	9	2 5	1 0	2 10½	1 1½	1	3	5	4	1	2	7	8
August, . . .	0.56	1.73	2.29	.63	17	4	5	0 4½	1 2½	1 2	2 0	10	. .	. .	. .	1	3	. .	17
September, . .	0.61	0.83	1.44	.39	16	9	12	0 9	1 2	0 10½	1 6½	5	2	5	7	1	1	4	5
October, . . .	2.11	1.12	3.23	1.18	13	7	4	2 4½	0 2	4 9	1 3	3	1	. .	5	9	2	5	6
November, . .	1.17	1.13	2.30	.57	16	5	6	0 11½	0 5	2 8½	1 6½	4	2	2	5	3	4	6	4
December, . .	1.41	1.58	2.99	.47	8	7	3	1 8	0 3	3 8½	1 3½	3	. .	. .	. .	6	6	5	11
, ...	14.02	12.97	26.99	1.18	177			14 11	11 8½	24 4	18 9	60	20	24	47½	52½	31	41	89

DIGEST *of daily Observations made at Athlone on the Fall of Rain, Rise and Fall of the Shannon, and Direction of the Wind, during the Year* 1840.

MONTH.	RAIN.							RIVER SHANNON.								WIND.							
	Quantity which fell each Month.			Greatest Fall in one successive Day and Night.	Number of Days without Rain.	Greatest Number of successive Days		Total Rise and Fall of the Shannon during each Month.								Number of Days in which the Wind was							
								Upper Mill.				Lower Mill.											
	Days.	Nights.	Total.			With Rain.	Without Rain.	Rise.		Fall.		Rise.		Fall.		North.	N. East.	East.	S. East.	South.	S. West.	West.	N. West.
	Inches.	Inches.	Inches.	Inches.	No.	No.	No.	Ft.	In.	Ft.	In.	Ft.	In.	Ft.	In.	No.	No.	No.	No.	No.	No.	No.	No.
January, . . .	1.03	1.80	2.83	.80	8	15	6	0	8½	1	2½	1	7	1	9	.	.	1	8	5	11	3	3
February, . . .	0.34	0.63	0.97	.17	12	8	0	0	4	2	0	0	2	8	6	9	1		3	4	5	4	3
March, ...	1.67	1.85	3.52	.78	11	7	4	1	3	0	11	1	8	1	10	5	1	. .	1	7	5	3	8
April, ...	1.62	1.68	3.30	1.00	20	8	6	0	10	0	10	1	10	2	2	9	8	1	5	4	1	1	6
May, ...	0.79	0.61	1.40	.83	17	5	8	0	4	1	7	0	1	2	1	6	. .	2	2	6	2	5	8
June, ...	1.30	1.30	2.60	.70	20	4	7	0	6	1	2	0	5½	2	7½	5	1	1	7	7	3	1	5
July, ...	1.78	1.93	3.71	.44	12	12	5	1	5	0	11	1	8	0	10	1	2	1	8	8	6	0	6
August, ...	2.54	2.52	5.06	1.45	14	14	10	2	4½	0	6½	5	6½	1	9½	10	1	2	5	2	1	5	5
September, . .	0.24	0.80	1.04	.43	19	9	12	0	2	2	4	0	8	2	11	. .	2	2	3	7	3	5	3
October, . . .	1.64	2.26	3.90	.72	9	12	4	2	5	0	10	3	10	0	9	7	2	2	3	4	7	1	5
November, . .	1.47	1.53	3.00	.61	14	12	0	1	11	0	9	2	11	1	0	4	1	3	3	7	3	. .	4

MONTH.	RAIN.							RIVER SHANNON.				WIND.							
	Quantity which fell each Month.			Greatest Fall in one successive Day and Night.	Number of Days without Rain.	Greatest Number of successive Days		Total Rise and Fall of the Shannon during each Month.				Number of Days in which the Wind was							
	Days.	Nights.	Total.			With Rain.	Without R.	Upper Sill.		Lower Sill.		North.	North E.	East.	South E.	South.	South W.	West.	North W.
								Rise.	Fall.	Rise.	Fall.								
	Inches.	Inches.	Inches.	Inches.	No.	No.	No.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	No.	No.	No.	No.	No.	No.	No.	No.
January, . . .	0.85	0.98	1.83	.54	14	7	3	1 4	1 1	2 3	1 5	2	1	3	9	8	4	2	2
February,. . .	1.25	0.96	2.21	.49	11	11	5	1 1	0 6	2 6	2 3	4	1	1	4	3	4	6	5
March, ...	0.01	0.31	0.32	.08	18	4	8	0 4	2 7	0 1	3 3	6	4	4	5	7	1	2	2
April,.	0.55	0.33	0.88	.11	8	9	2	1 2½	0 11	0 10	1 11	8	1	1	. .	3	1	6	10
May, ...	1.96	1.14	3.10	.71	11	10	4	2 5	0 8½	4 6	1 5	1	1	. .	11	7	8	3	. .
June, ...	0.83	0.55	1.38	.28	16	6	8	0 1	2 6	0 3	3 1	7	2	1	2	2	4	2	10
July, ...	0.79	0.14	0.93	.31	19	6	5	0 10½	1 1½	0 5	2 4	6	1	1	2	6	3	6	6
August,. . . .	0.43	0.97	1.40	.45	20	4	8	0 11	1 6	0 10½	1 4½	8	. .	2	. .	3	3	6	9
September, . .	1.10	0.69	1.79	.66	16	6	8	1 3	1 0	1 2	1 4	4	. .	2	. .	3	4	7	10
October,*. . .	0.01	0.31	0.32	.08	18	4	8	1 9	0 8	2 8	0 6	. .	6	4	3	8	4	4	2
November, . .	2.47	1.22	3.69	.85	17	4	6	3 1	0 11	4 0½	0 11½	3	1	. .	3	14	2	3	4
December, . .	2.60	3.05	5.65	.89	14	5	3	2 10	1 2	3 4½	1 3½	2	3	3	10	3	1	2	7
-tal, ...	12.85	10.65	23.50	.89	193			17 2	14 8	22 11½	21 1½	51	21	22	49	67	39	49	67

accidental circumstance prevented the Rain Gauge Registry being kept in October, but the month was dry throughout, and the figures are assumed to be the same as occurred in March.

IGEST *of daily Observations made at* ATHLONE, *on the Fall of Rain, Rise and Fall of the Shannon, and Direction of the Wind, during the Year* 1848.

MONTH.	RAIN.							RIVER SHANNON.				WIND.							
	Quantity which fell each Month.			Greatest Fall in one successive Day and Night.	Number of Days without Rain.	Greatest Number of successive Days		Total Rise and Fall of the Shannon during each Month.				Number of Days in which the Wind was							
								Upper Sill.		Lower Sill.									
	Days.	Nights.	Total.			With Rain.	With-out R.	Rise.	Fall.	Rise.	Fall.	North.	North E.	East.	South E.	South.	South W.	West.	North W.
	Inches.	Inches.	Inches.	Inches.	No.	No.	No.	Ft. In.	Ft. In.	Ft. In.	Ft. In.	No.	No.	No.	No.	No.	No.	No.	No.
January, . . .	1.20	0.95	2.15	.29	12	3	5	0 2½	2 9	0 3	4 10	4	2	4	6	4	2	1	8
February, . . .	2.95	2.41	5.36	.71	3	12	2	3 3	1 2	4 11	0 9	. .	. .	. .	. .	7	7	8	7
March, ...	2.04	1.23	3.27	.68	8	13	3	0 10½	2 3½	0 6	3 3	6	4	1	1	6	3	2	8
April, ...	1.45	1.11	2.56	.65	17	6	6	0 6	1 7	1 6	3 10	8	2	. .	4	3	3	3	7
May, ...	0.67	0.28	0.95	.31	21	4	9	0 1½	1 6½	. . .	2 11	3	. .	3	4	9	3	6	3
June, ...	0.44	1.07	1.51	.22	13	5	5	0 8	0 8	1 0	1 2	2	3	2	2	8	4	5	4
July, ...	1.17	2.24	3.41	.77	14	8	8	1 5	1 2	2 2	1 7½	6	2	1	2	2	7	8	3
August, ...	3.25	2.09	5.34	1.11	8	11	2	3 0	0 11½	3 4	0 10	1	1	2	4	2	3	10	8
September, . .	1.08	1.84	2.92	.85	16	3	3	0 7	1 8½	0 7	2 1½	4	3	. .	6	3	7	3	4
October, . . .	1.94	1.47	3.41	.96	17	4	6	2 0	1 3	3 0	0 3	6	6	1	4	5	4	4	1
November, . .	0.97	0.55	1.52	.52	17	8	14	2 4	1 9	2 0	2 1	5	4	. .	. .	6	2	4	9
December, . .	0.50	0.53	1.03	.29	19	4	7	2 6	2 2	4 9	3 8	. .	. .	2	10	12	3	3	1
Total, .	17.66	15.77	33.43	1.11	165			17 5½	19 9	24 0	27 4	45	27	16	43	67	48	57	63

No. VII.

METEOROLOGICAL JOURNAL,

COMMENCING

1st JANUARY, 1849, AND ENDING 31st DECEMBER, 1849.

BY

GEORGE YEATES.

◆

The instruments employed, and the general circumstances of the mode of observing, have been described in the preliminary observations to the Tables of the year 1843, in the 2nd volume of the Proceedings of the Academy, Appendix V.

	JANUARY.						FEBRUARY.						MARCH.				
	Thermom.		Barom.	Rain.	Wind.		Thermom.		Barom.	Rain.	Wind.		Thermom.		Barom.	Rain.	Wind.
	Max.	Min.					Max.	Min.					Max.	Min.			
1	42°	37°	30.150	. . .	S. E.	1	45°	36°	30.130	.025	S. W.	1	45°	31°	29.834	.020	N.
2	43	33	29.966	.010	S. E.	2	51	42	30.220	.120	W.	2	47	40	30.034	.010	N.
3	34	24	29.680	. . .	S. E.	3	53	46	30.264	. . .	W.	3	51	39	30.276	. . .	W.
4	33	28	29.760	. . .	S. E.	4	52	47	30.368	. . .	S. W.	4	54	46	30.332	. . .	S. W.
5	38	32	29.800	.108	N. E.	5	52	45	30.426	. . .	S. W.	5	52	44	30.450	. . .	N. W.
6	40	36	30.012	.006	S. E.	6	50	43	30.344	. . .	W.	6	50	36	30.500	. . .	S. W.
7	41	37	29.936	.012	S. E.	7	50	44	30.266	. . .	W.	7	52	46	29.900	.010	N. W.
8	54	42	29.586	.080	W.	8	52	43	29.974	.080	N.	8	44	38	29.920	.002	N. W.
9	45	38	29.550	.016	W.	9	46	38	30.300	. . .	S. W.	9	42	28	30.346	.030	N. W.
10	51	37	28.884	.300	N. W.	10	51	43	30.220	.020	N. W.	10	37	26	30.464	. . .	N. W.
11	46	38	29.666	.030	N. W.	11	40	32	30.800	. . .	W.	11	44	34	30.250	. . .	S. W.
12	45	35	29.826	. . .	S. W.	12	46	25	30.576	. . .	E.	12	52	36	30.238	.006	W.
13	51	44	29.568	.350	N. W.	13	47	32	30.446	. . .	N. W.	13	55	48	30.280	. . .	N. W.
14	54	46	29.358	.800	N. W.	14	49	35	30.600	. . .	W.	14	55	44	30.356	.050	N. W.
15	46	38	29.886	.020	N. W.	15	47	42	30.550	. . .	N. W.	15	53	45	30.390	. . .	W.
16	45	35	29.706	. . .	S.	16	46	30	30.436	. . .	N. W.	16	53	36	30.338	. . .	N. W.
17	51	41	29.692	.120	W.	17	54	32	30.586	. . .	W.	17	53	34	30.228	. . .	S. E.
18	50	38	29.614	. . .	S. W.	18	50	37	30.382	. . .	W.	18	58	33	30.000	. . .	S. E.
19	59	44	29.750	.040	E.	19	52	47	29.826	. . .	W.	19	56	45	29.902	. . .	S. E.
20	46	33	30.100	.510	N. W.	20	50	40	29.680	.100	W.	20	51	43	30.070	. . .	S. E.
21	52	37	29.780	. . .	S. W.	21	42	35	29.942	.120	W.	21	56	41	30.268	. . .	N. W.
22	53	36	29.996	.220	S. W.	22	52	42	29.718	.080	N. W.	22	55	48	30.108	.002	N. E.
23	48	40	30.268	.110	W.	23	49	36	29.963	.060	W.	23	55	33	30.134	. . .	N. E.
24	51	46	30.234	. . .	S. W.	24	47	34	29.650	.045	N.	24	46	40	30.020	.010	N. E.
25	50	47	29.840	.006	S. W.	25	42	29	29.462	. . .	E.	25	49	47	30.072	.010	S. E.
26	53	36	29.734	.100	S. W.	26	41	30	29.700	. . .	E.	26	47	35	30.014	.022	N. E.
27	43	34	29.720	. . .	S.	27	43	25	29.920	. . .	W.	27	49	33	29.278	.070	W.
28	44	33	29.400	.200	W.	28	44	38	29.750	.100	W.	28	48	38	29.340	.040	N. E.
29	30	38	30.000	. . .	S. E.							29	42	38	29.420	.250	N. E.
30	48	34	29.784	.150	S. W.							30	43	32	29.100	.420	S. E.
31	53	38	30.188	.060	S. W.							31	46	30	29.290	.100	N. E.

APRIL.						MAY.						JUNE.					
	Thermom.		Barom.	Rain.	Wind.		Thermom.		Barom.	Rain.	Wind.		Thermom.		Barom.	Rain.	Wind.
	Max.	Min.					Max.	Min.					Max.	Min.			
1	49°	37°	29.260	.160	S. E.	1	63°	40°	30.184	. . .	S. E.	1	67°	46°	30.100	.020	N. W.
2	49	35	29.210	.110	W.	2	66	36	30.020	. . .	E.	2	68	52	30.076	. . .	W.
3	47	34	29.538	. . .	N. W.	3	60	49	29.949	. . .	N. E.	3	69	42	30.180	.060	W.
4	57	35	29.442	.006	S. W.	4	63	45	29.920	. . .	N. E	4	70	45	30.076	. . .	E.
5	46	41	29.344	.080	E.	5	66	47	29.924	. . .	S. E.	5	72	51	29.950	. . .	W.
6	51	41	29.316	.020	S. E.	6	60	44	29.924	. . .	E.	6	66	42	30.144	. . .	S. E.
7	48	43	29.170	.200	S. E.	7	53	44	30.034	. . .	E.	7	69	39	30.188	. . .	S. E.
8	53	43	29.400	.010	S. E.	8	51	42	30.172	. . .	E.	8	69	39	30.020	. . .	E.
9	47	42	29.568	.370	S. E.	9	58	35	30.050	. . .	E.	9	65	51	29.928	. . .	E.
10	45	48	29.780	. . .	S. E.	10	60	42	29.900	. . .	E.	10	67	41	29.899	. . .	N. E.
11	45	38	29.874	.006	N. E.	11	55	46	29.938	. . .	E.	11	63	38	29.900	. . .	W.
12	48	32	29.772	.006	N. W.	12	59	40	30.062	. . .	E.	12	63	45	29.980	.060	N. W.
13	48	31	29.250	.100	N. W.	13	63	49	29.828	.008	S. W.	13	60	38	30.088	.100	N. E.
14	46	32	29.236	.240	N. E.	14	69	48	29.510	. . .	S. W.	14	68	40	30.100	. . .	S. E.
15	47	41	29.832	.050	E.	15	58	47	29.500	.750	N. W.	15	70	48	29.938	. . .	S. E.
16	48	37	29.850	. . .	N. E.	16	64	50	29.164	.040	S. W.	16	67	40	29.950	. . .	W.
17	51	28	29.880	.060	N. W.	17	68	48	29.100	.080	S. W.	17	63	39	30.064	.150	S. E.
18	38	27	29.990	.006	N. W.	18	56	50	29.016	.100	S. W.	18	67	47	30.064	. . .	W.
19	43	30	29.668	.300	N. E.	19	57	42	29.910	. . .	S. E.	19	69	53	29.650	.070	W.
20	44	29	29.844	.020	W.	20	59	50	29.540	.270	S.	20	66	38	30.088	. . .	W.
21	43	36	29.776	.200	S. E.	21	60	47	29.720	.080	S.	21	67	54	30.068	.030	W.
22	48	42	29.862	.060	N. W.	22	58	48	29.516	.060	S. W.	22	64	45	30.108	. . .	W.
23	53	41	29.682	.120	N. W.	23	54	49	29.974	.140	W.	23	73	56	29.912	.030	N. W.
24	54	39	29.628	.160	S. W	24	59	53	29.962	. . .	W.	24	70	44	29.900	. . .	S. E.
25	52	40	29.668	.012	S. W.	25	58	50	29.938	.090	W.	25	71	54	29.788	. . .	S. E.
26	54	39	29.649	.040	W.	26	67	50	29.862	.025	W.	26	73	52	29.922	. . .	S. W.
27	56	41	29.449	.035	S. W.	27	65	40	30.050	. . .	S. W.	27	67	54	29.940	. . .	W.
28	51	41	29.600	.050	S. W.	28	66	45	30.230	. . .	N. W.	28	69	50	30.040	. . .	W.
29	58	36	30.036	.070	W.	29	66	46	30.150	. . .	W.	29	69	52	30.012	. . .	S.
30	62	49	30.150	. . .	S. E.	30	61	47	30.128	.200	N. W.	30	70	50	30.144	.040	E.
						31	66	46	29.850	.080	E.						

	RAIN.	MEAN TEMP.		RAIN.	MEAN TEMP.
January	3.248	46.4	July	2.237	69.32
February . . .	0.750	48.28	August	3.234	66.71
March	1.052	49.68	September. . .	3.432	61.93
April	2.491	49.37	October	3.707	51.84
May	1.923	60.90	November. . .	1.689	48.53
June	0.500	67.70	December . . .	3.309	42.97
				29.732	

Brocas Sculp.

Richd. Kirwan Esqr. LL.D. F.R.S. &c. &c.

No. VIII.

BIOGRAPHICAL ACCOUNT

OF

THE LATE RICHARD KIRWAN, ESQ.,

PRESIDENT OF THE ROYAL IRISH ACADEMY, &c.

BY

MICHAEL DONOVAN, ESQ., M. R. I. A.

(SEE PAGE 480.)

HAVING long felt, with regret, that there exists no circumstantial and authentic biography of the celebrated philosopher whom this Academy once owned as its President, and whose well-earned reputation extended to all parts of the civilized world, I determined, should opportunity ever offer, to collect materials, and contribute my humble meed towards the accomplishment of so desirable an object. Through my good fortune, the descendants of Mr. Kirwan lately placed in my hands the family records of his life, at the same time expressing a wish that I would give them publicity in the proper form; I am, therefore, now in a condition to lay before the Academy a sketch of one who contributed so much to its scientific reputation, by his writings and researches. The Royal Irish Academy is the fit depository for the history of a life, of which the most valuable period was devoted to the advancement of its objects.

Richard Kirwan, whose life and writings constitute the subjects of the following sketch, affords one of those rare instances in which the possession of an ample fortune, and the desire of devoting it to the interests of science, coincide in the same person. Wealth, which in other hands might have been squandered unprofitably or culpably, became in his the instrument of extending the boundaries of knowledge, of adding to the means of human happiness, and of exalting the scientific and literary character of the country which gave him birth. Like Bacon, Boyle, and Lavoisier, on whom fortune and science lavished their treasures, he repaid their favours by efforts earnest and successful; and while he enlarged the circle of the sciences by his genius, he held up a bright example for imitation in the purity of his life, the benevolence of his heart, and the modest simplicity of his manners.

The Kirwans are descended from an ancient and respectable English family, who emigrated to this country in the reign of Henry the Sixth. The herald, says Mr. Hardiman, tells us that Maoldabhreac, son of Fiobhran, son of Finghin, descended from Heremon, second son of Milesius, was father of Ciorrovan, or Kirwan, from whom the Kirwans are descended. Clement Kirwan, in 1648, built the castle of Cregg, in the county of Galway, which was the latest edifice of that description erected for the purpose of defence in that part of Ireland. He was succeeeded in the family estates by his son, Captain Patrick Kirwan, whose son was Martin Kirwan, originally a Roman Catholic, like all the rest of the family at that time, but who, for a considerable period of his life, had conformed to the Established Church, although on his death-bed (1741) he was attended by a Romish priest. Martin Kirwan had four sons, Patrick, Richard, Andrew, and Hyacinth.

Richard, the subject of the following memoir, being the second son of Martin, was not born to the fortune which he afterwards inherited; he was, therefore, destined for a profession, and that of a clergyman of the Church of Rome was selected for him. His family, originally professing the Roman Catholic religion, are now all Protestants.

Martin Kirwan resided, for the most part, in Galway, but occasionally at Cloughballymore, in the county, the seat of Patrick French, Esq., his wife's father. In the latter place, in 1733, Richard was born, but in a little time after was removed to the family residence in Galway, where he remained until the death of his father in 1741. He was then placed with his grandfather French at Cloughballymore, his mother remaining at the family residence with her other children.

In his earliest days he gave promise of what he was to arrive at in mature age. At five years old he could conjugate a French verb; and at six, happening to hear some persons disputing an historical question, little Richard, who had been playing with a dog, undertook to illuminate the company, and actually set them right on the subject. When he was seven, he made an abridgment of the ancient history, none of the best no doubt, but a remarkable undertaking for so young a child: during his subsequent life, he was distinguished by his knowledge of the history of all nations. Such was his devotion to study at this early period, that, to avoid disturbance, he used to ascend a tree with a book, borrowed without leave from his uncle's library, and read for hours, regardless of the shouts of servants sent in search of him. He read every morning in bed, from dawn until the family hour of rising, and then concealed his borrowed treasure until next morning. It is not surprising that he should have been intended for a learned profession.

His elder brother, Patrick, in 1745, was sent to complete his education at Poictiers; the penal laws having virtually excluded persons of his persuasion from the British universities. Meanwhile, Richard was instructed at Cloughballymore by the Reverend Nicholas M'Nelly, a Dominican friar, who was resident chaplain to the family; and, on the death of his grandfather, he was sent with his brothers Andrew and Hyacinth, to the free school on Erasmus Smith's foundation. At this school he continued until he was seventeen years of age (1750); he was then sent to Poictiers to join his brother Patrick, and there they both remained until Patrick became of age, when the latter proceeded to Italy. In about a year after this period, his mother died; Richard had been devotedly attached to her, and her loss caused him the most poignant grief.

In that academy, Richard read the Latin classics with avidity, and had so accurately committed to memory the Odes of Horace, that he contested with the most distinguished students a premium for the repetition of any ode that might be required: he lost it by the commission of two mistakes, while his successful opponent made but one. It is a singular fact, that, skilled as he at this time was in the Latin language, he was unacquainted with the Greek, and remained so until an advanced period of his life, when he learned it without assistance. The Latin was always the most favourite language of the foreign academies; and it is well known that, even in the English universities, the foundation of Greek professorships was so late as the first introduction of the Reformation.

Richard quitted Poictiers about the beginning of the year 1754, for Paris. He appears about this time to have entered on his noviciate, either at St. Omer's or Hesden. He was so excellent a Latin scholar, that the College of Jesuits considered him qualified to act as Professor of Humanity; and during his noviciate he taught in the habit of a Jesuit. Many of the French clergy who survived the Revolution have acknowledged him as their best professor. One of his pupils was the Abbé Lynch, afterwards Vicar-general of Paris.

When first he arrived at Poictiers, the superiors of the College were anxious that he should, in the first instance, acquire a knowledge of French; but Richard pertinaciously refused to learn the language of the land of his banishment, or to associate with any but boys from his own country. An ingenious stratagem of his tutor overcame his repugnance: it appears that even at this period (æt. 17), he was much devoted to chemistry; during the hour permitted for play, he was in the habit of studying some chemical books which he brought from Ireland; his tutor, finding further importunity fruitless, took from him all his English chemical books, and substituted French works on the same subject. His love for the science in which he afterwards became so distinguished prevailed; Richard not only soon read and spoke the French language with fluency, but, before four years had elapsed, had made some progress in forgetting his native tongue.

In May, 1755, we find Mr. Kirwan at Hesden, in the Catholic

Netherlands; and one of his letters informs us, that he was about to abandon his noviciate. His income at this time was 300 livres a year, allowed him by his brother Patrick, who was seven years older. But the tragical fate of this brother, which occurred during the previous year, rendered Richard the proprietor of the family estates, amounting to £3000 per annum, which in some years after increased to £4000. This melancholy event occurred in Dublin, in Lucas's coffee-house, situate where the Royal Exchange now stands. Patrick Kirwan was an accomplished swordsman, as well as an accomplished gentleman. At this period, fencing was an indispensable part of a polite education, and every gentleman carried a sword. Mr. Kirwan having, in the coffee-room, some difference with a Mr. Brereton, Usher of the Irish House of Commons, they proceeded to decide their quarrel by the sword; and, although Brereton was totally inexperienced in the art of fencing, he mortally wounded his expert adversary. Kirwan's remains were brought from Dublin to his family burial-place in Galway; he died unmarried, and his property descended to Richard, who soon after returned to Dublin, being then in the twenty-second year of his age (1755).

It is probable that by abandoning his noviciate he intended to renounce the order of Jesuits, whatever his previous predilections might have been. A noviciate in the order of Jesuits was of longer duration than that of the other monastic orders, in which a year and a day was the usual period. The Jesuits were to be qualified for the business of the world, and their probationary terms were continued for several years. The time of ordination did not precede the age of thirty-three, while in the other monastic orders it was twenty-three. Mr. Kirwan, therefore, did not take orders.

For some time after this, Mr. Kirwan appears to have been undetermined in the course he ought to pursue. At one time he was disposed to abandon his estates, and to retire to the society of Jesuits on a pension of fifty pounds a year. He might have alienated his lands, and have devoted the produce to the common stock of the order; but he was impressed with the idea, that as he had derived his estate by descent, he was no more than a trustee of the reversion, and was bound to preserve it in his name and family. After much consideration, he felt still disposed to adopt his originally intended profession, and was actually engaged in Dublin (1757), with that object in view. But a young gentleman of large fortune, handsome person, and pleasing manners, like Kirwan, received such flattering attentions from the Galway families resident in Dublin, that he could scarcely escape the nets spread for him in all directions. Caught he certainly was; the young philosopher fell in love; he preferred the marriage vow to the monastic vow; and communicated his situation and opinions to his brother Andrew, in a pithy and very candid letter, of which the following is an extract:

"*Dublin*, *March* 8, 1757.

"MY DEAR BROTHER,—I received your's two days ago, and was agreeably surprised at your not calling for money as usual, and that immediately, and by return of post. I shall send you some, *on that account*, very soon, if it be possible. Miss C—— is not taller than Miss F——, very ugly and very fat. Miss H—— is very disagreeable to me; and Miss D—— does not know how either to read or write. * * * If you be not averse to it, I like another of £4000, who possesses every amiable qualification, &c. &c.

"I am your most affectionate, loving brother,
"RICHARD KIRWAN."

To this the following answer was sent by Andrew:

"*London*, *March* 21, 1757.

"DEAR BROTHER,—I received your kind favour on the 16th, but could not answer it sooner, as I kept my bed eight days. If you are in love with the lady, my being averse to her is of no consequence; but this I know, that before the honeymoon is out you will repent it. £4000 is nothing to you; it is soon gone, &c. &c."

Much good advice followed, which, however, was not taken. Prudent Andrew's counsel came too late, for the deed was already done; and there is reason to believe, from a bill afterwards filed in Chancery, that, even when the philosopher asked his brother's consent, it was an *ex post facto* piece of courtesy, his marriage having taken place in February, 1757, nearly a month anteriorly to the letter, when Mr. Kirwan was in his twenty-fourth year.

Although it appears from Mr. Kirwan's letter to his brother, that prudential motives had some influence in the choice of a wife, we find that he manifested but little caution in the manner of carrying his intentions into effect, and but little care about property during the subsequent part of his life. Previously to his making proposals, he had been splendidly received by the relatives of the lady, who was sister to Sir Ulick Blake, and daughter of Sir Thomas Blake, of Menlo, in the County of Galway. He was entertained with French wines and the choicest fruits of the country. In the moments of festivity he asked the young lady the startling question; the answer may be inferred from the fact, that they were soon after married; and they lived for eight years in uninterrupted affection.

His brother's prediction, that before the honeymoon was out he would repent his marriage, was not altogether without some prospect of being realized, for, the morning after his wedding, Mr. Kirwan was arrested and thrown into prison. His wife, it is true, was *entitled* to £4000 fortune, but until after the sale of the estate she could procure no ready money; she had incurred some liabilities, and thus her husband became responsible to the creditors. Mr. Kirwan remained in prison until his agent sent him the money. The recovery of this fortune was a subject of litigation even after his death, it having been made a part of the marriage portion of one of his daughters; but it was eventually recovered.

Mr. Kirwan resided with the Dowager Lady Blake, his mother-in-law, for several years after his marriage, at her seat at Menlo. Here he was enabled to indulge to the utmost his taste for study; he collected an excellent library, and fitted up a laboratory, where he often spent eight hours a day.

Besides the immense stock of learning which he had acquired at the Jesuits' College, he was at the age of twenty-three acquainted with as much chemistry as was then known. He extended his researches to new discoveries, but his zeal was checked by an occurrence which he afterwards frequently mentioned as the cause of his temporary estrangement from his pursuits. Dr. Black's discoveries respecting carbonic acid, and the cause of causticity, at this time occupied universal attention. Mr. Kirwan wrote him several letters containing observations on his views, but Black made no reply. So disappointed was Kirwan at this rather uncourteous treatment, that he relinquished his chemical inquiries, and did not resume them until he subsequently abandoned the profession of the law. He and Dr. Black afterward became the best friends.

But he might have had additional reasons for relaxing the life of study which he led. His application and devotion to his investigations in the early hours of morning were condemned by his mother-in-law, who actually told him, that she had never intended her daughter to be the wife of a monk; and, unlike our first parent, Eve, she recommended abstinence from the tree of knowledge. In reply, Mr. Kirwan, a little ruffled, made some unlucky allusions to the champagne he had drank on the evening he proposed for the lady; but this little altercation did not in the least interrupt the harmony which subsisted between him and his wife.

About six years after his marriage he began to entertain doubts of the religion which he had hitherto professed, and commenced the study of its controverted points. He read, hesitated, the arguments of Chillingworth almost convinced him; but he was decided during a visit to Paris with his wife, undertaken for the recovery of her health. The circumstance, as related by himself, was as follows. At a book-stand, he chanced to purchase a book without a title, with the subject of which he was unacquainted, but it proved to be religious controversy; it gave the arguments on both sides of the question, as he conceived, with impartiality. He studied it every morning, while suffering under the inflictions of his hairdresser, then a tedious and important attendant of a French dressing-room; and during these intervals, the only moments allowed him at that time for study, he decided in favour of the Protestant faith; and in a year after, on the 15th of February, 1764, Mr. Kirwan regularly conformed to the established religion. It is probable he did so at that particular time, in order to qualify himself for the profession of the law, which he afterwards adopted. The Act of the first year of George II. required a public profession of the Protestant faith for two years previously to being called to the Bar; accordingly, in two years after his conformity, that is, in 1766, he became a member of the Irish Bar, having commenced his study of the law in London during the year 1761.

Mr. Kirwan has often described the study of the English law as an Herculean labour. He applied himself intensely to it, and, owing to the depth of his researches, his progress was slow, but his retention of principles was stronger than that of his contemporary students. His earliest acquaintance with the feudal system was derived from the study of the German constitution; and so earnest was he in the pursuit of his object, that he paid a special visit to Germany for the purpose of consulting the original authorities.

During his legal studies in London, his wife died at Menlo, in 1765. Her illness was not at first alarming, and hence his friends did not inform him of her indisposition. He returned to Ireland a week after her death, and then for the first time learned his bereavement. His regret was poignant, and he ever afterwards spoke of the circumstance with deep regret. She left two daughters, Maria Theresa, afterwards married (1793) to Lord Trimleston, father of the present peer; and Eliza, to Colonel Hugh Hill, subsequently of the Battle-axe Guards (1792).

While Mr. Kirwan attended the practice of the law Terms, he maintained no domestic establishment; his winters were spent in Dublin, and his summers in Galway, or on circuit. Being engaged in some difficult cases, and having received in each a fee of but two guineas, he was so dissatisfied with its disproportion to the difficulty of the questions, that he determined to quit the profession. Apprehensive that his clients might be injured by the delay if he returned their briefs, he actually gave to other counsel larger fees than he had himself received, in consideration of their taking the business off his hands. On one occasion, a brief was laid before him which occupied three days in the bare operation of noting the margin. He offered this well-noted brief, with the fee which he had received, to Mr., afterwards Sergeant, Palmer, who objected that any sum under £20 would not be remuneration. Mr. Kirwan paid the difference out of his own pocket. On another occasion, he transferred a brief to Mr. Scott, afterwards Lord Clonmel, and handed him £30, including the small fee which had been allowed him. Mr. Kirwan finally relinquished the profession of the law about the year 1768, after having practised two years.

An ardent mind like his could ill brook the inglorious ease in which he might have floated down the stream of life, possessed as he was of ample means of living independently of the exertion of his intellectual faculties. Having abandoned the study of the laws of man, he soon after betook himself to the laws of nature, and with what energy, talent, and industry, the Transactions of this Academy, those of the Royal Society, the various journals, and his detached works, bear ample testimony.

In 1769 Mr. Kirwan, having left Ireland, commenced an establishment in London, now for the first time since the death of his wife. He purchased an excellent library, became entirely devoted to his studies; every consideration of property was absorbed in his ardour in the pursuit of knowledge. He no longer took any interest in his other affairs; he committed everything to his agent, and could scarcely be induced to correspond with him.

He returned to Dublin in 1772, and took temporary lodgings in Peter-street, his daughters being placed at a celebrated French school in Aungier-street. Here he frequently indulged himself in a recreation which much delighted him,—the society and conversation of very young persons,—and often invited the school-fellows of his daughters along with his young relations. This innocence of mind and simplicity of character have been in many instances the adjuncts of the highest order of intellect.

A year after this date (in 1773), Mr. Kirwan retired with his family to the county of Galway, where he inhabited his castle of Cregg, and soon resumed his philosophical pursuits. Here he commenced the study of the Greek language, which had been so unaccountably neglected in the Jesuits' College: he was now in his fortieth year. The derivations, difficult to the generality of students, were to him the most interesting parts of the study; and so enthusiastic did he become in his admiration of the Greek, that he considered it the primæval language of mankind. He also at this time revived his knowledge of several modern languages of Europe, so necessary to his chemical and mineralogical pursuits.

In 1777 he returned to London, and took the house No. 11, Newman-street, Oxford-street; his motive for preferring so obscure a situation being its proximity to the suburbs and good air, in both of which he delighted. Here he resided for ten years, making occasional short visits to Ireland. He now prosecuted his scientific labours in an atmosphere far more congenial to the development of his immense powers of mind than that which he had forsaken. He regularly attended the meetings of the Royal Society, of which he was a Fellow; was honoured with the Copley medal; became one of its most active members; and was the friend and associate of such men as the Honourable Henry Cavendish, Dr. Priestley, Dr. Fordyce, Sir Joseph Banks, Dr. Ingenhousz, Sir George Staunton, Horne Tooke, Cavallo, and the celebrated Edmond Burke, with many others.

At his house in Newman-street Mr. Kirwan received his friends every Wednesday evening. The conversations were learned, various, and always interesting. I have in my possession some specimens of the conversations, noted by Martin Dean, Esq., of Galway, and much regret that it would be out of place to introduce them here. Mr. Dean says, that those who attended were for the most part men of science; wits did not frequent the meetings much, and no one endeavoured to shine at the expense of another. He who expressed himself with most precision and elegance (Mr. Dean says) was Horne Tooke; he delighted chiefly in metaphysical subjects. Sir George Staunton was highly respected; his observations were marked by originality. Dr. Priestley generally preferred attending to the conversations of others, than entering into them himself, although his conversational powers were known to be very great. Mrs. Macauley gave her opinions with the greatest modesty, and never touched on learned subjects unless urged to it.

Conversazioni were also held every Sunday evening by Sir Joseph Banks, President of the Royal Society; and at these Mr. Kirwan was a constant attendant.

This was probably the most splendid, but not as yet the most useful part of Mr. Kirwan's life. His residence was the resort of rank and talent. A gentleman by birth, education, manners, and property, he maintained a position in society which placed him on a footing of equality with the most exalted in rank or the most profound in acquirements. He corresponded with all the savans of Europe; and such was the estimation in which he was held, as we are informed by Lord Cloncurry, that "even during the hottest period of the war, his letters were suffered to pass free from all parts of Europe." His conversazioni were often visited by the foreign ambassadors, and were the fashionable resort of foreigners who visited London at the termination of the war; and to such, Mr. Kirwan's knowledge of the continental languages rendered the meetings more interesting. The Empress Catherine the Second of Russia was pleased to transmit to him her portrait, as a token of the high estimation in which she held him,—a gift equally honourable to the donor and the receiver. In the preface to his Geological Essay, he designated her "Catherine the Great—the immortal Benefactress of Mankind."

Previously to the termination of the American war, Mr. Kirwan made an effort to procure from the county of Galway his valuable library. His books were dispatched from Galway, September 5, 1780, in a vessel belonging to that port. In a few days this vessel was met by an American privateer, and, singularly enough, it happened that the name of the captain was Thomas Kirwan, and that he was descended from the family of Cregg. He allowed the domestics of his illustrious relative to proceed on their voyage to London, but the library was too rich a prize to be saved through deference to a name; the captain evinced his good taste and admiration of the collection by carrying it off to America.

About the year 1787, Mr. Kirwan's health becoming delicate, he was compelled to relinquish the splendid life he led in London, a life equally delightful to himself and all who associated with him. During that year he returned to Dublin, and soon after took the house No. 6, Cavendish-row, where he continued all the rest of his life. He there resumed his literary and scientific career. He became a member of the Royal Irish Academy, then in its infancy; and it is almost needless to add, that its Transactions soon became the depository of the valuable results of his labours. These communications can scarcely be estimated according to their original value, in consequence of the rapid advances which chemical science has made within the last half century, and to which Mr. Kirwan so ably contributed. At the period of the first promulgation of his investigations, his name was to be seen more frequently quoted than that of any other chemist in all the scientific journals of Europe.

In Dublin he also resumed his conversazioni, and, as usual, associated with the chief literary and scientific characters of the day. His intimates were the Provost and Vice-provost; Doctors Magee, Graves, Young, Kearney, Hall, Elrington, and Davenport, then Fellows of the College. He was also on terms of friendship with Lord Norbury, Bishop Law, Speaker Foster, Judge Daly, Lord Charlemont, then President of the Royal Irish Academy, General Vallancey, &c.; and he frequently received visits from the different Lords Lieutenant at his house.

Mr. Kirwan, at this time one of the first chemical authorities in Europe, had greatly extended the boundaries of the sciences which he cultivated. He was equally eminent as a mineralogist, and had signalized himself by being the author of the first systematic work on mineralogy that had appeared in the English language. As a geologist he deserves the gratitude of mankind, for the publication of his essays in which he undertook the task of vindicating the cosmogony of Moses. At that period, the account given in the book of Genesis was deemed by many to be incompatible with the facts elicited by geological research. Mr. Kirwan himself told me, that he was an object of derision to the French geologists for his adherence to the Scripture account. Happily, in the present day, every well-authenticated geological discovery is found to be supported by and to agree with holy writ, although by no means with the date which Archbishop Tenison has assigned to the creation of the world, and on which Mr. Kirwan has relied, as if it were any part of the Scripture. The geological essays evince the possession of an immense fund of varied knowledge.

But for Mr. Kirwan's intelligence and energy Ireland might not now be in possession of the splendid collection of minerals known in the Royal Dublin Society's Museum as the Leskeyan Cabinet.

Mr. Kirwan, while a member of the Society, was chiefly instrumental in purchasing the collection, for which a fund was provided by the Irish Parliament in 1792, amounting to £1200. In addition to the minerals, he obtained, without any additional expense, a collection of shells, some anatomical preparations, an herbarium, and other subjects of natural history. He also arranged the minerals. Besides presenting him with their thanks, the Society voted him a medal made of Irish gold, with an appropriate inscription; and procured his portrait to be painted by Mr. Hamilton. This portrait, painted when Mr. Kirwan was in his sixty-ninth year, now hangs in the Board Room of the Royal Dublin Society.

As evidences of Mr. Kirwan's talents and industry, we need only refer to the rapid succession of his publications, and the surprising diversity of their subjects. Perhaps the best way of giving an idea of the estimation in which this remarkable man was held throughout the civilized world, will be to give a list of honours conferred on him in foreign countries and in his own. He was Honorary Member of the Academies of Stockholm, Upsal, Berlin, Dijon, Philadelphia, and of the Mineralogical Society of Jena; he was Fellow of the Royal Societies of London and Edinburgh, and Honorary Member of the Manchester Society. On the death of Lord Charlemont, in 1799, he was elected President of the Royal Irish Academy. In his latter days, a chemical and mineralogical society formed in Dublin was after him called the Kirwanian Society, and of this he was President. He was also President of the Dublin Library Society. He had the honorary title, without an income, of Inspector-General of His Majesty's Mines in Ireland. He was elected Perpetual Member of the Amicable Society of Galway. From the University of Dublin he received the degree of Doctor of Laws, and was always allowed an honourable seat at the examinations for fellowship. By some of the French savans he was designated, by way of excellence, "the Philosopher of Dublin." But the following fact would in itself speak trumpet-tongued, if there were no other evidence of the high opinion which the French chemists entertained of him. He had written a work in defence of the phlogistic hypothesis of Stahl. The French philosophers were occupied in endeavouring to subvert that hypothesis, and to establish a revolution in chemistry, as they had already done in their political constitution. Kirwan's work was an obstacle which it was necessary to remove; and of such magnitude was it considered, that it was not only translated into French, but partitioned amongst no less than five of the most eminent chemists which France could at that time boast of, in order that they might reply to his arguments: these were Lavoisier, Berthollet, Morveau, Fourcroy, and Monge; and, truth to say, never was a refutation more complete.

At length, convinced that his opinions were no longer tenable, Mr. Kirwan, with a candour which only belongs to superior minds, publicly acknowledged the subversion of the phlogistic hypothesis, which he had so laboured to defend. It is said that Lavoisier took no small pride in the surrender of the Irish philosopher's opinions; which, if true, shows the estimation in which he held their previous defender,—a feeling which I do not think was reciprocal; for in a conversation which I had on this subject, with Mr. Kirwan, a year before his death, he told me that Lavoisier's wife was a better chemist than Lavoisier himself. The lady is well known to have been possessed of considerable talents and accomplishments; it is known, that with her own hands she engraved the plates for her husband's last work; but I have not been able to discover any authentic historical record of her superior acquirements as a chemist. After the murder of her husband she became the wife of another eminent person, Count Rumford.

Such were the honours which crowded on the Irish philosopher. The simplest and most convincing mode of showing how far he was entitled to them will be to enumerate the various subjects which occupied his mind, and this will be best carried into effect by giving a list of his works. In the Philosophical Transactions, from 1781 to 1786, both years inclusive, we find six papers under his name; the titles are as follow:

1. Experiments and Observations on the Specific Gravity and Attractive Powers of various Saline Substances.	1781
2. Continuation of the same subject.	1782
3. Conclusion of the same.	1783
4. Remarks on Mr. Cavendish's Experiments on Air.	1784
5. His Reply to Mr. Cavendish's Answer.	1784
6. Experiments on Hepatic Air.	1786

In the Transactions of the Royal Irish Academy, between the years 1788 and 1808, both years inclusive, we find that he presented no less than thirty-eight memoirs; the following are their titles:

1.	Essay on the Variations of the Barometer.	1788
2.	Observations on Coal Mines.	1789
3.	On the Strength of Acids, and the Proportions of Ingredients in Neutral Salts.	1790
4.	A comparative View of Meteorological Observations made in Ireland since the Year 1788, with some Hints towards forming Prognostics of the Weather.	1793
5.	Reflections on Meteorological Tables, ascertaining the precise Signification of the Terms Wet, Dry, and Variable.	1793
6.	State of the Weather in Dublin from 1st of June, 1791, to 1st of June, 1793.	Unknown.
7.	Examination of the supposed Igneous Origin of Stony Substances.	1793
8.	A Prize Essay on the Question proposed by the Royal Irish Academy, "What are the Manures most advantageously applicable to the various Sorts of Soils, and what are the Causes of the beneficial Effect in each particular Instance?"	1794
9.	Meteorological Observations made in Ireland.	1794
10.	Experiments on a new Earth found near Stronthian, in Scotland. (Mr. Kirwan may be considered one of the discoverers of this earth.)	1794
11.	On the Composition and Proportion of Carbon in Bituminous and Mineral Coal.	1795
12.	Essay on the Substances used in Bleaching.	1795
13.	Synoptical View of the State of the Weather in Dublin.	1796
14.	Thoughts on Magnetism.	1796
15.	On the Primitive State of the Globe, and its subsequent Catastrophe.	1796
16.	Synoptical View of the State of the Weather.	1796
17.	Synoptical View of the State of the Weather.	1796

18.	Additional Observation on the Proportion of Real Acid in the three ancient known Mineral Acids, and on the Ingredients in various Neutral Salts, and other Compounds.	1797
19.	Essay on Human Liberty.	1798
20.	Synoptical View, &c. (In the Contents, but not in the Volume.)	
21.	Synoptical View, &c.	1799
22.	Observations on the Proofs of Huttonian Theory of the Earth.	1799
23.	An Illustration and Confirmation of some Facts mentioned in an Essay on the Primitive State of the Globe.	1800
24.	An Essay on the Declivity of Mountains.	1800
25.	On Chemical and Mineralogical Nomenclature.	1800
26.	Remarks on some Sceptical Positions in Mr. Hume's Inquiry concerning the Human Understanding, and his Treatise on Human Nature.	1800
27.	Synoptical Table of the Weather in Dublin.	1800
28.	On the Variations of the Atmosphere.	1801
29.	Synoptical View of the Weather in Dublin.	1801
30.	Synoptical View, &c.	1802
31.	Synoptical View, &c.	1803
32.	On Space and Duration; of Duration, Time, and Eternity.	1805
33.	Synoptical Table.	1805
34.	On the Primæval Language of Mankind.	1805
35.	Description of a new Anemometer.	1808
36.	Synoptical View, continued to 1808.	1808
37.	An Essay on Happiness.	1809
38.	On the Origin of Polytheism, Idolatry, and Grecian Mythology.	1808

Some of the foregoing essays were afterwards much enlarged, and published in independent volumes. Besides these, he published a System of Mineralogy, which passed through two editions, and was translated into the French, German, and Russian languages. His work on Logic appeared in two volumes octavo; it was intended for the use of students of the law, and was dedicated to the Chief Justice of the Common Pleas. His Essay on the Temperature of different Latitudes was much noticed on the Continent. His work on phlogiston, as already mentioned, was translated into French, and commented on by five of the most celebrated French chemists; it was twice translated into German by different persons, viz., Gibelin and Lorenzo Crell. He also published geological essays; an Essay on the Analysis of Mineral Waters; a volume of metaphysical essays; a few copies of a treatise on the interpretation of the Apocalypse. He wrote, but did not publish, a treatise on Music, in which he was profoundly versed, although not a performer on any instrument. He had also a treatise partly written, entitled Commentaries on Locke's Essay on the Human Understanding, but did not live to finish it. Several other manuscripts on various subjects were found after his death; amongst which were a tract on the Atonement, a subject which in his early days had deeply interested him; some papers on the Unitarian Controversy; and an Essay on the Duties of Jurors.

His works may be comprised under the heads of Divinity, Metaphysics, Logic, Law, Philology, Music, Mechanical Philosophy, Chemistry, Mineralogy, Mining, Geology, Meteorology. He who was well acquainted with these twelve very different subjects, and who could write excellent treatises on particular branches of them, may well be considered deserving of the honours which were bestowed on him.

From this enumeration of Mr. Kirwan's works, and the variety of their subjects, some idea may be formed of the extent of his knowledge, and the diversified power of his mind. But his acquirements were far more extensive than his actual writings would indicate. Those who enjoyed the pleasure of his society, and there are several of them still living, can bear testimony that scarcely any subject of conversation could be introduced which he was incapable not only of sustaining, but of illustrating with some fact or opinion that was new to his hearers. And while he communicated information, it was done so artfully and delicately, that he appeared rather to remind the hearer of what he already knew, than to instruct him in what he should be expected to have known.

Colonel Hugh Hill, his son-in-law, says that his powers of conversation were remarked as most extraordinary, being equally rich on all subjects, and interesting alike to old and young, male or female. He had the talent of adapting his conversation to his audience. " I have known," adds Colonel Hill, " children to leave their toys and their juvenile gambols to listen with delight to his numerous stories and sketches from history; for he was not only conversant with the history of all civilized nations, but even of the most savage and least known: his mind and his memory were so replete with varied knowledge, that he had only to make choice of what he deemed at the time best suited to the taste of his hearers, and in the selection he never failed."

Yet with such qualifications he was not a monopolist of conversation; he acted on the apothegm of Democritus, that he who is too much a talker defrauds his hearers: he could be a patient listener, and on subjects that he understood much better than the speaker. While he was resident in London, he occasionally met Dr. Samuel Johnson in company. On one occasion the Doctor was pronouncing, in his pompous manner, a dissertation on the invention and manufacture of gunpowder; he concluded by observing to Mr. Kirwan (then unknown to him), " Perhaps you know something about it;" to which Mr. Kirwan replied, " Yes, I have both made it and written upon it." The Doctor seemed not a little abashed when he found that he had ventured too far, and that his modest hearer was much better acquainted with the subject than himself.

It happened on another occasion, when the trade-winds were the subject of conversation, that Dr. Johnson gave his opinion in his usual manner, *ex cathedrâ*. Mr. Kirwan ventured to differ with him, to the amazement of the company, and brought forward such an irresistible torrent of arguments, that the learned Doctor never after entered into a discussion with Mr. Kirwan, although he was little in the habit of succumbing to the opinion of others; for it was said of him, that " if his pistol missed, he knocked his opponent down with the but-end."

Although modest and unobtrusive, Mr. Kirwan was not without feeling for himself that respect which was evinced for him by the nations of Europe, although in a less degree by his own countrymen. He was annoyed at finding that his system of mineralogy was rarely referred to by Irish authors, while they referred to foreign systems in which his arrangements had been adopted, although overlooked at home. This cause of complaint he felt particularly in the instance of the book which represented the arrangement of the University collection of minerals. Mr. Hardiman remarks: "It has been pointedly observed, as a reflection on Ireland, that the abilities of Mr. Kirwan were more appreciated, and that his reputation was greater, in every country of Europe than in his own." If so, the circumstance only proves the degeneracy of Irish science at the time. To be less appreciated at home than elsewhere is, however, not uncommon; and to prove that it is not unnatural, we have an authority that is not to be disputed. When acquirements are of such a nature as to be but little understood in any particular country, and are much more cultivated elsewhere, it is to be expected that they will be valued only in proportion as they are comprehended. And further, the person with whom we are in constant habits of association and familiar intercourse generally makes less impression, and calls forth less admiration, than the same person would have done if viewed through the mysterious media of time and distance.

Mr. Kirwan was ardently attached to music, although he did not perform on any instrument, and it is said that his unpublished, and now lost, treatise on harmony, evinced profound knowledge in its author. So devoted was he to Italian music, that his daughters, who were accomplished practical musicians, were obliged to avail themselves of his absence from home when they chose to indulge in Irish or Scottish melodies. Notwithstanding this preference, he assisted Mr. Edward Bunting in collecting the national music of Ireland; and, in the preface to the work entitled "Ancient Music of Ireland," Mr. Bunting declares that "his principal acquisitions were made in the province of Connaught, whither he was invited by the celebrated Richard Kirwan the Philosopher, who was of such influence in that part of the country, as procured the Editor a ready opportunity of obtaining the tunes both from high and low."

I have been fortunate enough to obtain, through the politeness of Dr. Jacob, a folio volume of manuscript music collected by Mr. Kirwan, and entitled "Pathetic Music, or the Language of the Passions, as expressed by Pergolese, Galuppi, Haisse, Cocchi, Perez, Pescetti, Piccini, Jomelli, Ciampi, Vinci, Bach, Vento, Guglielmi, Arne, Handel, and others." The conception is original, like every other work of its author. He has classified the melodies of the most celebrated Italian and a few English composers, according to the passions which the music and words are intended to express; as grief, pity, dismay, anxiety, remorse, reproach, disdain, and various others. The extent of knowledge of Italian music displayed in this book is quite remarkable, especially as it was collected at a period when Italian music was little known in the British isles.

Lady Morgan, describing her first interview with Mr. Kirwan, when the conversation turned on music, informs us that she chanced to say something in praise of that of Ireland. "Mr. Kirwan," she says, "called my taste barbarous, and became quite vehement in his expression of abhorrence of Irish music. 'Madam,' he said, 'I left Ireland at your age, and, full, as you are now, of all the vulgar errors of enthusiastic patriotism, I thought there was no poetry like Irish poetry, no music like Irish music. When I returned I could not endure either.'" He then informed her, that at Christmas and other festivals he used to throw open the servants' hall at Cregg Castle to all comers, beggars, bards, and story-tellers, after the old Connaught fashion; and at night he took his place amongst them, and made each guest tell a story, recite a poem, or sing a song in Irish. "Madam," he exclaimed, "it was too much for me; it almost threw me into convulsions." Lady Morgan then sung for him the song of "Ned of the Hills," composed in the time of Henry VIII., and accompanied herself on her harp. Before she had finished the first stanza, the tears gushed from his eyes,, and seizing her hand, he said with vehemence; "Madam, I won't hear you—'tis terrible—it goes to the very soul!—it wrings every nerve in the body!" "Then, Sir," replied Lady Morgan, "I ask no more; the effect which Irish music produces on you is the best proof of its excellence." "You may as well say," retorted Mr. Kirwan, "that the howl of a dying dog, which would produce the same effect, is the proof of its excellence. My dear child, give up your Irish harp, and your Irish howl, and study Italian music; you are worthy of knowing it; you have a true musical organization, but it is all perverted."

Mr. Kirwan was of a kindly and feeling character; many stories are told of his affection for his mother, his grief for a temporary separation from her in his boyish days; and even the illness induced by his grief. In his mature age, it is said that when he was informed of the death of his friend Saussure, he absolutely shed tears, although his friendship was only founded on correspondence and similarity of pursuits. His humane disposition caused him to form strong attachments to animals; he was fond of making pets, and these were sometimes of an unusual kind. When he was living in the county of Galway, some of his people captured a wild, fierce, young eagle, and presented it to him. He hit upon the following mode of taming it: he starved it for one or two days, and during the whole time caused a boy to tease it in its cage, in order to prevent its sleeping. He then made his appearance, and, having beaten and scolded the boy, he drove him away, as if in anger; he next presented a plate of meat to the eagle; and by repetition of this process a few times, the affections of the bird were won, and he became devotedly attached to his master. When Mr. Kirwan walked or even rode about his grounds, the eagle was his companion, sometimes perched on his shoulder, sometimes soaring in the sky, and wheeling in many a circumvolution until he again descended to his master's shoulder. But the poor bird was doomed to be the subject of a woeful tragedy. A visitor, who knew nothing of Mr. Kirwen's favourite, happened to be out shooting, and on his way home saw the eagle descending from the sky to meet his master, who was at a little distance, taking his accustomed walk. The sportsman levelled, fired, and down fell the royal bird, dead, almost at his master's feet. Mr. Kirwan's grief is not to be described; he long mourned his poor favourite.

At another time he had cultivated a friendship of a different kind; his pets were two Irish wolf-dogs, two mastiffs, and two greyhounds, all of uncommon size. They all accompanied him when he went abroad, and on one occasion, perhaps, saved his life. One day he went on horseback to visit a friend, attended by his whole canine suite: the friend lived at a distance of thirty miles. On arriving, he found the family in the utmost confusion, the house and most of the offices having been burned to the ground the day before. Necessity compelled him to deposit himself and suite in a small room, with an earthen floor well covered with straw, and a door opening into the court-yard. The door having neither lock nor latch, he secured it by placing against it a table and chair. Mr. Kirwan and the six dogs were soon asleep; but during the night he was awoken by a violent pushing against the door, and the downfal of the whole barricade. An uproar immediately ensued; a dreadful conflict was commenced; howls, growls, barking, and grunting made a horrible commixture of discordant sounds, which gradually died away, and all was tranquillity. In the morning a curious scene presented itself: his bed was soaked with blood; his face was stiff with dried gore; and on the floor lay dead—six large hogs. The solution of the mystery was this. Mr. Kirwan's dormitory was also that of the hogs, who had been unjustly deprived of it; they, determined to recover their rights, burst in the door; the dogs defended their master, killed the hogs, and, exulting in their victory, saluted him with caresses, which smeared him with the blood of the vanquished foe, and left him to appear before the family in a singular plight.

The foregoing anecdote has been narrated by Lady Morgan in her "Book of the Boudoir," but differently. I have reason to believe that my version is correct.

The humane feelings and exceeding sensibility of Mr. Kirwan's mind would have suffered severely on account of the cruelty so often inflicted by mankind on the lower animals, but for a peculiar opinion in which he indulged, and which occasionally afforded him great comfort, or at least saved him from much pain. This opinion was elicited from him in a conversation with Lady Morgan on the occasion of the death of a horse turned out to die on a piece of waste ground, under atrocious circumstances. He said, "'That the idea of sufferings imposed without a cause on the part of the sufferer, and which were to have no retribution, no recompense, was too painful an idea to indulge in, and too derogatory to the wisdom and goodness of the Supreme Being to be credible; that he had, therefore, long been convinced, that those signs of suffering manifested by brute animals were but means to cherish and promote the sympathies of man, and to check his natural tendency to tyrannize and misuse power, whenever it was granted to him. In a word, that he was a sincere disciple and a zealous advocate for the doctrine of Gomez Pereira (which was popularized by Descartes), who conceived that all appearances of sensibility manifested by animals are fallacious, and that the brute species are mere machines divested of all feeling.' There is something so amiable in this horror of injustice, that it is impossible not to pardon the inconsequence of the reasoning."

It often happens that persons of extraordinary genius differ as much from the generality of mankind, in their habits, as they exceed them in their intellectual powers. A difference in their mode of thinking naturally produces a difference in their mode of acting; hence the eccentricities which so often furnish subjects of amusement to those whose mind is of normal constitution. Mr. Kirwan was far from being exempt from peculiarities, and these were sometimes sufficiently ludicrous. An anecdote is known of him in his family, which, as it at once illustrates several of his eccentricities, is worth relating.

On a certain occasion, the city coal-yard in Dublin was on fire; it burned for three days, in spite of every effort to extinguish it, and threatened the adjoining houses. As a last effort, the Lord Mayor, accompanied by some gentlemen of note, waited on Mr. Kirwan, whose scientific knowledge they hoped might suggest a remedy. It was on a summer's day, the period at which he was about to take his dinner; and, to secure himself against the intrusion of visitors, the chain was on the hall-door. The Lord Mayor having knocked at the door, Mr. Kirwan's servant lad, Bernard Pope, opened the door, but anticipated the usual inquiry, by saying in a determined tone, that his master could not then see any one. "Tell him," replied the civic authority, "that the Lord Mayor requests to speak with him on a matter of great importance." "If the Lord Lieutenant, or the King himself, required to see him, I dare not admit either," vociferated Pope: "it would be as much as my place is worth." "But," said the Lord Mayor, "the city coal-yard is on fire." "If all Dublin was on fire," said the imperturbable Pope, "I could not admit you, for my master is at dinner." "Then," said the Lord Mayor, "at least let us remain in some other room until your master has dined, for our visit is one of urgency." To this Pope hesitatingly acceded, and the gentlemen were shown to the front drawing-room, Mr. Kirwan's usual sitting-room, while the philosopher was finishing his dinner in the adjoining one. The Lord Mayor, in his impatience, had strided up stairs before the servant, and had just laid his hand on the handle of the door, when he was suddenly arrested by the shrill voice of Pope crying, "Oh! Sir, they will get in, they will get in." "What will get in?" said the Lord Mayor, looking round in astonishment. "Oh! the flies, Sir, the flies!" ejaculated Pope, who opened the room-door with the greatest precaution, and barely as much as sufficed to permit the bodies of the visitors to be squeezed through; while, with the other hand, he rapidly waved a handkerchief to keep off any of the troublesome winged intruders. Mr. Kirwan, like Domitian, had a great abhorrence of flies; he allowed his servants a small premium per dozen for killing them, and the presence of one of them was a serious misdemeanour.

After a short time Mr. Kirwan appeared; the Lord Mayor delivered his errand, and the Philosopher pronounced the remedy in four monosyllables:—"Throw sand on it." This was done, and the fire which threatened the city for three days was quickly extinguished.

Mr. Kirwan's precaution of chaining the hall-door while he was at dinner, and refusing to see any person, arose from a very great difficulty in swallowing, owing to debility in the muscles of the throat, which caused him to make such contortions while eating as would be disagreeable to the beholders. The same affection obliged him to abstain from all kinds of meat except ham, the saltness of which, although it were ever so tough, enabled him to get it down. His dinner was a bowl of milk and a ham, with which he commenced on Sunday, dined on it every day after, it being reheated each time, until Saturday, and on the next day a new one was brought on the table. He very seldom indulged in a glass of wine; and when he did, it was some kind of Spanish white wine with a small bit of sweet cake. His reason for allowing himself this indulgence so seldom was, that the wine had the effect of raising his pulse to 150, its natural standard being 70.

On account of this difficulty of swallowing, Mr. Kirwan, even when he dined out of his own house, never ate in the presence of any one. Lord Cloncurry informs me, that his practice at Lyons, when visiting there, was to retire to a particular room in the house, and there he had his dinner served; on which occasion he dispensed with the ham, and contrived to get down minces: as soon as the family had dined he immediately joined them. I have learned from other sources, that he either dined in this manner with his friends, or avoided arriving until immediately after the removal of the first course, he having previously had his dinner at home. Mr. Kirwan was very intimate with Lord Cloncurry, and used to spend much time at his house along with Mr. Chenevix, who resided in the neighbourhood. The two chemists were of very opposite politics, Mr. Kirwan leaning to Lord Cloncurry's opinions, yet the three friends lived in perfect harmony.

A curious feature in Mr. Kirwan's character was the gravity of countenance which he maintained on occasions that drew forth laughter from every other person, although he would laugh continiously and in paroxysms at things that little affected any one else. The following anecdote illustrates the former peculiarity. One evening he was at tea, with his daughters, when his physician, the late Dr. Egan, came in and sat down. The Doctor having risen from his seat to leave his cup on the table, in returning without looking behind, missed his chair, and fell flat down on his back, with his heels up. Mr. Kirwan, who was in the middle of a long speech, did not perceive the cause, but, hearing a noise, turned round, and seeing the Doctor with his heels in the air, inquired gravely, "Doctor Egan, what are you doing there?" This question, asked in so solemn and calm a manner, perfectly convulsed his daughters, already biting their lips to suppress their mirth. Mr. Kirwan, instead of being moved by any contagious influence, became extremely angry, threatened to send them both out of the room, and solemnly assured them that in their dying moments they would repent of this. Politeness might forbid the expression of mirth, but eccentricity alone could control risibility on such provocation, and excite feelings of such asperity.

Colonel Hill, Mr. Kirwan's son-in-law, now more than eighty years of age, has thus described to me the occupation of Mr. Kirwan's day. He rose at four o'clock in summer, and half an hour later in winter, and descended to his study, which consisted of two rooms, each having a fire at all seasons. These rooms were furnished with presses all round; they were filled with books, and when they would hold no more, the tables became gradually covered, and at length the floor. Here he remained until nine o'clock, when tea and toast were brought to him. He then completed his toilet; walked out for exercise or business, but always followed by his carriage; returned at two; resumed his studies until five; dined in his study; descended to the drawing-room, where he met his daughters and visitors, this being the hour for their admission. Such was the uniform tenor of his private life while he resided in Cavendish-row; and he would not allow any infringement on his habits.

But he had public evenings: each Wednesday at six o'clock was the time appointed for the admission of his friends, and then they were politely and hospitably received. At seven the knocker was removed from the hall-door, and this was the signal to persons arriving at that hour that he was not to be seen; for he felt disinclined to disturb his guests with introductions or the noise of the knocker. Those already admitted were entertained with tea and coffee, and other refreshments, but above all with conversation enriched by extensive knowledge, travel, and intercourse with the most remarkable men of the age. During this interval Mr. Kirwan sat or reclined on a sofa, rolled in a cloak, and another thrown over his lower limbs, his hat on, a long screen behind him, and a blazing fire before him, no matter whether winter or the dog-days. He always solicited permission from his company to wear his hat, and was allowed the privilege of wearing it even in Courts of justice; nay, he wore it at the levees of the Lords Lieutenant, which he constantly attended in the capacity of a state officer, being Inspector-General of His Majesty's Mines in Ireland.

After entertaining his company until nine o'clock in summer, or half-past eight in winter, he commenced a certain routine of operations. He took out his watch and wound it; it was now the duty of those who were familiar with his habits, to remind him that his hour was come, or, if they were all strangers, he announced it himself, but requested the company not to move until he could escort them. His next process was slowly to remove the buckles of his shoes and knees, the conversation still continuing. After this, the company was marched off, under his escort, to the head of the staircase, and then they dispersed to their respective quarters, while he retired to bed, from which he rose next morning, at four o'clock in summer, and somewhat later in winter, to resume his accustomed studies.

But his slumbers were to be occasionally interrupted. His servant, Pope, already mentioned, always slept in his room; his business was to administer to his master, once or twice during the night, a little tea, out of a teapot, by introducing the spout into his mouth. But Pope, overpowered by sleep, would occasionally make woeful mistakes; and it was nothing uncommon to hear his master in the middle of the night exclaim, "You booby, you are pouring the tea into my eye!"

Mr. Kirwan was so affable and conversable, and adapted his conversation so judiciously to his company, that his society was much sought after by ladies; and he, in his turn, was much pleased with their's, especially if they had literary pretensions. In their company he was lively and playful, and divested himself entirely of the character of the philosopher. He was indeed always of a cheerful disposition. If to literary acquirements a lady superadded personal attractions, she was sure to interest Mr. Kirwan the more, for indifference to beauty was no part of his philosophy. Shortly after Lady Morgan's appearance as a literary character, she received a flattering token of Mr. Kirwan's approbation, which she thus describes in her usual volatile and lively manner: "A plain, dark, old-fashioned chariot drove to the door, and up came a card thus inscribed:—'Mr. Kirwan, to pay his respects to the fair authoress of the Wild Irish Girl.' My stars!" she exclaims, "what a fuss! The great Richard Kirwan, the philosopher, the chemist, the comely, the elegant, the celebrated! I flew first to the harp to get up an attitude, and then back to the table to seize my pen, and when the door opened I was placed in a thoughtful position, with the contemplative look of a doctor of the Sorbonne, or of Lydia Languish; but the apparition, which for a moment halted at the threshold, and then moved on in solemn gait, actually made me start. A tall, gaunt figure, wrapped from neck to heel in a dark roquelaure, with a large-leafed hat flapped low over the face, presented the very picture of Guy Fawkes, with nothing wanted but his dark lantern: the venerable, but very singular-looking philosopher stood confessed. The conversation soon became animated, and to me highly interesting."

After detailing the conversation, Lady Morgan describes Mr. Kirwan's invitation to take tea with him, and gives his words as follows: "You must take tea with me on Thursday next, it is my shaving day; I only pay visits, or receive ladies, twice a week, on my shaving days. I have a good pianoforte, and a fine collection of Italian music; you shall try both. My tea-table hour is half-past five." She accordingly waited on him at the hour appointed, and thus describes her visit: "On entering the drawing-room, the heat was so excessive, that I was afraid I should never go through the *séance*. Although it was a fine, mild, spring evening, an enormous fire blazed on the hearth, and a screen of considerable dimensions, drawn closely round it, excluded every breath of air. Within this enclosure, on a large, cumbrous sofa, sat the advocate of phlogiston. He was dressed in the same roquelaure and slouched hat in which he had visited me, with, however, the addition of a shawl wrapped round his neck." This was his ordinary costume, whether he received visitors or not.

If Mr. Kirwan was gallant in the society of women, he was not deficient in the allied quality of courage amongst men, a quality which at that time characterized, in rather too great a degree, the county from which he derived his origin: but the exercise of it should be after his own manner, for he was peculiar in everything. When he was a young man, happening to be in Paris, he received a challenge from a hot-headed Frenchman. Mr. Kirwan at once declined it, and expressed the utmost contempt for persons who would decide a quarrel by such unchristian means: but he added, "That he always wore a sword; that he walked every morning early at a particular solitary place which he named; that if he met any person there who seemed disposed to attack him, he would show him whether he was competent to defend himself." Mr. Kirwan, like his deceased brother, was an accomplished swordsman, but he heard no more from his antagonist.

Amongst his peculiarities was one common enough amongst scientific men; he cared not how extensive his correspondence was, so long as it was confined to his favourite pursuits. He wrote letter after letter to Bergman, Scheele, Chaptal, Klaproth, and Lavoisier; but he could not bring himself to correspond upon business, and he discouraged others from writing to him. On one occasion, when a letter from his brother absolutely required an answer, he began in the following manner:—"Dear Brother, I read over twice the letter *you were pleased to send me*, which to me, who hate reading or writing on any business, was a very disgusting task," &c.

Yet he was an excellent landlord, was liberal to his tenants, and watchful of their interests; his opinion being, that it was as much his duty to transmit to his heirs a prosperous tenantry as an unincumbered inheritance. As a tenant, nothing could exceed his punctuality; regularly, on each gale day, three distinct knocks at his landlord's door announced that Mr. Kirwan had arrived with the rent. The three distinct knocks were his constant method of making his arrival known wherever he visited.

In whatever could promote the branches of knowledge which he cultivated, he was liberal, annually allocating a large sum for the support of his well-appointed laboratory, and the supply of his library, into which he admitted all the foreign and domestic journals. The Royal Irish Academy received a token of his regard in the bequest of the philosophical part of his library. When he was engaged in making observations on the climate of Ireland, he gratuitously distributed no less than thirty barometers and thermometers, made under his own inspection, to enable persons in different places to make observations. Such was the confidence reposed in his predictions of the weather, founded on observation of past seasons, that the farmers would, in many cases, not venture to sow a crop without consulting him by letter; and such was the amount of labour thus imposed on him, that he was absolutely compelled to employ a secretary on this kind of correspondence. As a further proof of Mr. Kirwan's liberality, it is stated by a member of his family, that he derived no pecuniary advantage from the publication of his numerous works, although his publishers made large profits ; his work on mineralogy, especially, realized a large sum. He did not forget the claims of the poor, and never passed a beggar in the street without giving a small sum, such as would supply an immediate necessity ; but he made it a point never to give more, fearing that it might be turned to a bad account.

But on proper occasions he could be munificent. He gave an estate of £800 a-year to his brother Andrew, at a peppercorn rent ; and, under some peculiar circumstances, he forgave a debt of £4000, rather than pursue the debtor. These acts may be explained either by generosity of character or by indifference to wealth, the latter of which qualities often influenced his actions, as is shown by the following remarkable fact. At one period of his life, Lord Chancellor Clare happened to be trying a cause of disputed property; in the course of the trial he exclaimed, "Why this property does not belong to either of these parties ; it belongs to Mr. Kirwan the philosopher; how came he to overlook it?" "My Lord," said Counsellor Lynch, "Mr. Kirwan did not overlook it; but he *is* a philosopher; he said he had enough already, and did not want it." It is very probable that not one person in the Court could comprehend such philosophy.

He appears to have been equally indifferent to honours. Lord Castlereagh offered to confer a baronetage on him, in the expectation that his great influence would assist in accomplishing the legislative union then in contemplation. This dignity Mr. Kirwan at once declined.

The present representative of the family, and possessor of the estates, is Richard Kirwan, Esq., grand-nephew of the philosopher, formerly an officer in the army.

Notwithstanding his long life of study, seven or eight hours being every day devoted to reading and writing for so many years, his sight remained unimpaired; and although he lived to be nearly seventy-nine years of age, he never used spectacles. He had a peculiar, and, as most persons would conceive, a very inconvenient mode of writing; he placed his paper on his knee, and in that disagreeable stooping posture wrote for hours without intermission.

It is said that, in greater or less perfection, he understood no less than nine languages beside English; two of these, the Swedish and Greek, he had learned without a master. I believe the list was as follows:—Latin, Greek, Hebrew, German, Swedish, French, Italian, Spanish, and Irish.

The habit of wearing his hat at all times was caused by his susceptibility of cold, and by a rheumatic affection to which he had been long subject. Perhaps the extreme precautions he took against cold increased his natural infirmity. When about to leave the house for exercise, his habit was to stand before the fire with his great-coat on and thrown open, in order, as he said, to lay in a sufficient supply of caloric to last for some time. The better to preserve his stock without waste, he walked in the street with such celerity, that he kept any one who joined him in a smart trot. If any one met him, he would not stop; the person must walk with him, at his pace, or quit, for he would not incur the risk of taking cold.

Towards the end of his life he relinquished the pursuits to which in his early days he had been devoted, and occupied the chief part of his time, as became his years, in the study of the Scriptures.

Along with high mental endowments, Mr. Kirwan, when young, possessed considerable personal advantages. Although slight in figure, his limbs were firmly knit and well put together, so that he might be considered a strongly made man; he was also extremely active. He was five feet ten inches in height, and remarkably erect in deportment; the back gracefully curved into a hollow. In his early and middle life he was considered handsome; his face was long, its expression grave and thoughtful; his head rather small, and his forehead not remarkably high. His eyes, when looking downwards, gave him, from the peculiar form of the upper lid, the appearance of being asleep.

Lady Morgan thus describes her father's recollection of the appearance of Mr. Kirwan in his early life: "I remember well," he stupendous fabric of the universe must have an author, is as incredible as untrue. By his defence of God's word, did he not give proof of his belief in that great Being whose mercy he invoked with his latest breath? It is true that he continually absented himself from any place of divine worship; the fact is easily explained by his experience of the injury he sustained by removal of his habitual covering from his head, even for a very short period.

The following is the account of his funeral, given by his faithful and attached servant, Bernard Pope, a man possessed of acquirements very unusual in his rank of life; it is in his own words, addressed to the Reverend Francis T. Hill, grandson of Mr. Kirwan: " His funeral took place on the 8th of June, 1812;* and although it was one of the clauses in his will that he should be buried with as little expense, and in as private a manner, as possible, yet such was the respect and friendship of his numerous friends and literary acquaintances, that his executors were obliged to deviate from the letter of his will. There were no cards of invitation issued; every attendance on the part of his friends to follow his mortal remains was voluntary on this mournful occasion. He was buried in St. George's churchyard, Lower Temple-street. The different bodies which composed the procession were, the members of the Royal Irish Academy; the Fellows and students of Trinity College; the Judges; the Benchers of the Honourable Society of King's Inns; the members of the Kirwanian Society; the members of the Royal Dublin Society, and of the Dublin Library Society; with some professors and students of Maynooth College. There were between 800 and 900 gentlemen in the procession, followed by a numerous train of carriages of the nobility and gentry. The route of the procession was as follows: from Cavendish-row through Sackville-street, Westmoreland-street, College-green, Dame-street, Parliament-street, Capel-street, Bolton-street, Dorset-street, and Temple-street, to the church. The funeral service was performed before a most respectable congregation, who wished to pay this last solemn rite to his memory; after which the coffin was deposited in the north side of the churchyard, in an angle near the street, the head of the coffin against the church wall. Although heart-sick at the time, I had the presence of mind to get one of the men employed to pick a stone out of the church wall, directly over the head of the coffin, in order that I might be able to identify the exact spot where my dear master's remains lay, should no monument be erected to his memory. I lately visited his grave, and felt the cavity in the wall. Mr. Kirwan was attended in his last moments by the Rev. Arthur Maguire, rector of St. Thomas's parish." Such is the statement, a little abridged, of an eye-witness. In addition to these honours, the Historical Society of the University offered prize medals to the authors of the most approved eulogies on the deceased philosopher.

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* A resolution of the Royal Dublin Society indicates that he was interred on the 5th of June.

Amongst his posthumous honours, the following resolution, adopted at a meeting of the Royal Dublin Society, June 4, 1812, when no less than seventy-seven of the most respectable citizens of Dublin, its members, were present, is perhaps the highest eulogium that could be pronounced:—"That this Society feels highly sensible of the *severe loss which they, in common with mankind*, have sustained by the death of their worthy member, Mr. Kirwan; and that, in testimony of their regard, they will attend his funeral tomorrow."

Sorry am I to say that, notwithstanding the suggestive anticipations of the faithful and feeling servant, the only existing monument of the celebrated President of the Royal Irish Academy is his works. Is this creditable to Ireland? His fortune, his talents, and his labours, were devoted to the honour of the Irish nation; what has that nation, lauded for generosity of character, done for him or his descendants in return? Nothing—absolutely nothing. That we may all live to see this blot removed from the scientific records of our country are my concluding words.

The following letter, found after the foregoing sketch was completed, evinces the early versatility of Mr. Kirwan, and his predilection for chemistry. He was at this time seventeen years of age. The letter also displays the excellent sense of his mother, the writer.

"*May* 16, 1750.

"MY DEAR DICKY,—I would write to you a good deal about your studies, if I thought it to much purpose; but I am pretty much of opinion, that experience alone must effect what advice will not at present. I apprehend that chemistry, or some such abstruse study, takes up your time and attention too much; for I believe philosophy, rhetoric, or any such study which you are to go through regularly, after one another, won't require such a number of books at once. The consequence will convince you, I fear when it's too late, of your studying any thing but as you are directed; doing any more is but a childish curiosity that would not be approved by persons of sense here, whom I have sounded on this head; and I am sure it is so there; they say that beginning chemistry before one has studied philosophy is beginning the wrong end. How confounding must that be, and pernicious to the body and mind? The faculties of the one, and the strength and growth of the other, cannot but be hurt and weakened by it extremely, neither being come to perfection yet in you that are so young. Therefore, let me tell you, if you go beyond the dictation of your masters, you are ruined. I write you this early enough to prevent your doing yourself any harm; and, my dear child, you can't imagine what comfort it would give me to hear that you take my advice in this particular. You see whether I have cause to be uneasy about it, when I tell you the misfortunes of two that were eminent in that way: one Furlong, who found out the way to make Bath metal, grew by study at last melancholy, let his beard grow, and talked to himself; in short, by all I heard, he was lost by it: and the Dominican friar, that found out the way to make gunpowder, blew himself up. There was the end of their labours and profound studies, as they fancied. There are several instances of people that were turned or touched, as they call it, by study, which makes me insist so long upon your not falling into the dangerous practice which I suspect you do, as you were so fond of it here, and not to be easily put off of what you would be inclined to. Your brother Patrick, if he had the greatest passion for any thing, I would require but just to let him know my reasons to disapprove on't, and he would be sure in a letter or two to answer my desire to the full, and seem ashamed to be the occasion of giving me so much trouble: he would let me know immediately that he will comply, and even without reluctance. What dangers has he not escaped, with God's blessing, by this happy temper! I read somewhere, in a French book, what I would have my children often consider; it runs thus: 'La plûpart des hommes employent la premiere partie de leur vie à rendre l'autre miserable.' This, you see, was a very just observation of the author.

"I am so uneasy to satisfy you, I leave six pounds in Mr. Usher's hands to buy anything for you that you will have a mind to; but it frightens me to think you would buy books for it.

"Write to me again about what books you want; if they be of chemistry, I'll never desire to know more of them. Adieu, dear Dicky; mind your health even for my sake, and take care of your immortal soul, that it may enter into the joys of our Lord, when you leave this valley of tears. Your grandmama French, who loves you greatly, often thinks of you, and gives you her blessing.

"I am, my dear Dicky,
"Your loving Mother,
"MARY FR. KIRWAN."

No. IX.

ACCOUNT

OF THE

ROYAL IRISH ACADEMY,

FROM 1ST APRIL, 1849, TO 31ST MARCH, 1850.

THE CHARGE.

	£	s.	d.	£	s.	d.
To Balance in favour of the Public on 1st April, 1849, ...	. . . .			216	19	10
Parliamentary Grant for 1849, ...	300	0	0			
Quarterly Warrants from Treasury, . . .	146	17	8			
Total from Treasury, . . .				446	17	8
INTEREST ON STOCK:						
One year's, on £1643 19 6, 3¼ per Cent.	53	8	7			
Ditto, „ 867 1 10, 3 „	26	0	4			
Total Interest on Stock, . .				79	8	11
STOCK SOLD:						
£150, 3 per Cent. Consols, at 95¼ per Cent.	142	13	9			
Forty-six days' Interest, ...	0	11	4			
Total amount of Stock sold, .				143	5	1
RENT OF STABLE, due 1st November, 1849,	21	0	0			
Deduct Poor Rate, ...	0	13	2			
				20	6	10
TRANSACTIONS AND PROCEEDINGS sold, . .	. . . .			18	3	9
LIFE COMPOSITIONS:						
Benjamin Lee Guinness, Esq., ...	21	0	0			
Rev. James Bewglass, ...	15	15	0			
Forward,	36	15	0	925	2	1

	£	s.	d.	£	s.	d.
Brought forward,	36	15	0	925	2	1
Rev. H. King, LL. D.,	21	0	0			
John Hart, M. D.,	6	6	0			
J. B. Kennedy, Esq.,	21	0	0			
P. D. Hardy, Esq.,	6	6	0			
Total Life Compositions,				91	7	0
Entrance Fees.						
J. J. Murphy, Esq.,	5	5	0			
Henry Kennedy, Esq.,	5	5	0			
Benjamin Lee Guinness, Esq.,	5	5	0			
Hon. Thomas Vesey, M. P.,	5	5	0			
D. F. Brady, M. D.,	5	5	0			
William Hill Luscombe, Esq.,	5	5	0			
William Frazer, Esq.,	5	5	0			
Lord William Fitzgerald,	5	5	0			
Rev. H. King, LL. D.,	5	5	0			
Alexander G. Melville, Esq.,	5	5	0			
Wellington A. Purdon, Esq.,	5	5	0			
Chichester Fortescue, Esq., M. P.,	5	5	0			
Christopher Moore, Esq.,	5	5	0			
Charles Fox, Esq.,	5	5	0			
Sir Robert Gore Booth, Bart., M. P.,	5	5	0			
C. G. Fairfield, Esq.,	5	5	0			
Total Entrance Fees,				84	0	0
Annual Subscriptions:						
J. H. Smith, Esq., ... 1849,	2	2	0			
Venerable Archdeacon Cotton, ,,	2	2	0			
Henry Clare, Esq., ,,	2	2	0			
Charles Ottley, Esq., ,,	2	2	0			
John Hart, M. D., ,,	2	2	0			
William Murray, Esq., ,,	2	2	0			
Rev. J. J. Taylor, D. D., ,,	2	2	0			
Hon. and Rev. William Wingfield, ,,	2	2	0			
J. S. Close, Esq., ,,	2	2	0			
F. Churchill, M. D., ,	2	2	0			
R. V. Boyle, Esq., ,,	2	2	0			
M. Longfield, Esq., ,,	2	2	0			
Jacob Owen, Esq., ,,	2	2	0			
Thomas Cather, Esq., ,,	2	2	0			
Charles Hanlon, Esq., ,,	2	2	0			
James Magee, Esq., ,,	2	2	0			
O'Neale Segrave, Esq., ,,	2	2	0			
F. V. Clarendon, Esq., ,,	2	2	0			
Forward,	37	16	0	1100	9	1

		£	s.	d.	£	s.	d.
Brought forward,		37	16	0	1100	9	1
W. B. Wallace, Esq.,	1849,	2	2	0			
Arthur R. Nugent, Esq.,	1848,	2	2	0			
Ditto,	1849,	2	2	0			
R. W. Townsend, Esq.,	„	2	2	0			
William Lefanu, Esq.,	„	2	2	0			
N. P. O'Gorman, Esq.,	„	2	2	0			
T. J. Tuffnell, Esq.,	„	2	2	0			
George M. Miller, Esq.,	„	2	2	0			
Robert Adams, Esq.,	„	2	2	0			
William Gregory, M. D.,	„	2	2	0			
Edmond Getty, Esq.,	„	2	2	0			
His Grace the Archbishop of Dublin,	„	2	2	0			
Sir Robert Kane, M. D.,	„	2	2	0			
C. T. Webber, Esq.,	„	2	2	0			
William Longfield, Esq.,	„	2	2	0			
James Pim, Esq.,	„	2	2	0			
Aquilla Smith, M. D.,	„	2	2	0			
William N. Hancock, Esq.,	„	2	2	0			
Rev. C. Porter,	„	2	2	0			
R. R. Madden, M. D.,	„	2	2	0			
Edward Bewley, M. D.,	„	2	2	0			
John Hamilton, M. D.,	„	2	2	0			
G. A. Fraser, Esq.,	„	2	2	0			
Rev. James Wills,	„	2	2	0			
John Finlay, LL. D.,	„	2	2	0			
Rev. Samuel Haughton, A. M.,	„	2	2	0			
Rev. R. J. M'Ghee, A. M.,	„	2	2	0			
Francis Barker, M. D.,	„	2	2	0			
Charles Bourns, Esq.,	„	2	2	0			
D. P. Starkey, Esq.,	„	2	2	0			
Abraham W. Baker, Esq.,	„	2	2	0			
Abraham W. Baker, Jun., Esq.,	„	2	2	0			
George Wilkinson, Esq.,	„	2	2	0			
Robert Cully, Esq.,	„	2	2	0			
Rev. John Alcorn,	„	2	2	0			
M. E. Talbot, Esq.,	„	2	2	0			
Rickard Deasy, Esq.,	„	2	2	0			
E. J. Cooper, Esq.,	„	2	2	0			
G. A. Hamilton, Esq., M. P.,	„	2	2	0			
J. W. M. Berry, Esq.,	„	2	2	0			
Rev. I. G. Abeltshauser,	„	2	2	0			
M. P. Darcy, Esq.,	„	2	2	0			
Samson Carter, Esq.,	„	2	2	0			
Sir J. K. James, Bart.,	„	2	2	0			
G. A. Kennedy, M. D.,	„	2	2	0			
Forward,		132	6	0	1100	9	1

		£	s.	d.	£	s.	d.
Brought forward,		132	6	0	1100	9	1
Rev. Edward Marks, D. D.,	1849,	2	2	0			
David Moore, Esq	„	2	2	0			
Rev. J H. Jellett,	„	2	2	0			
Thomas Oldham, Esq.,	„	2	2	0			
Algernon Preston, Esq.,	„	2	2	0			
Robert Reid, M. D.,	„	2	2	0			
H. G. Hughes, Esq.,	1848,	2	2	0			
Ditto,	1849,	2	2	0			
Philip Bevan, M. D.,	„	2	2	0			
William M'Dougall, Esq.,	„	2	2	0			
Michael Barry, Esq.,	„	2	2	0			
John Aldridge, M. D.,	„	2	2	0			
Rev. Joseph Fitzgerald,	„	2	2	0			
William Monsell, Esq., M. P.,	„	2	2	0			
J. M. Neligan, M. D.,	„	2	2	0			
J. S. Eiffe, Esq.,	„	2	2	0			
M. O. R. Dease, Esq.,	„	2	2	0			
Earl of Enniskillen,	„	2	2	0			
Rev. George Longfield,	„	2	2	0			
M. H. Stapleton, M. B.,	„	2	2	0			
F. W. Conway, Esq.,	1848,	2	2	0			
Ditto,	1849,	2	2	0			
Sir Philip Crampton, Bart.,	1848,	2	2	0			
Ditto,	1849,	2	2	0			
Rev. William Lee,	„	2	2	0			
H H. Joy, Esq.,	„	2	2	0			
William Armstrong, Esq.,	„	2	2	0			
James S. M'Donnell, Esq.,	„	2	2	0			
A. E. Gayer, LL. D.,	1848,	2	2	0			
Ditto,	1849,	2	2	0			
Durham Dunlop, Esq.,	„	2	2	0			
W. T. Lloyd, Esq.,	„	2	2	0			
George Yates, Esq.,	„	2	2	0			
H. C. Beauchamp, M. D.,	„	2	2	0			
Oliver Sproule, Esq.,	„	2	2	0			
R. C. Walker, Esq.,	„	2	2	0			
Rev. N. J. Halpin,	„	2	2	0			
Philip Jones, Esq.,	„	2	2	0			
James Patten, M. D.,	„	2	2	0			
Thomas Grubb, Esq.,	„	2	2	0			
Arthur Jacob, M. D.,	„	2	2	0			
R. W. Smith, M. D.,	„	2	2	0			
Jonathan Osborne, M. D.,	„	2	2	0			
John Davidson, Esq.,	„	2	2	0			
Right Hon. Chief Baron,	„	2	2	0			
Forward.		226	16	0	1100	9	1

		£	s.	d.	£	s.	d.
Brought forward,		226	16	0	1100	9	1
E. S. Clarke, M. D.,	1849,	2	2	0			
T. F. Kelly, LL. D.,	„	2	2	0			
James Claridge, Esq.,	„	2	2	0			
R. A. Wallace, Esq.,	„	2	2	0			
Lord Dungannon,	1850,	2	2	0			
Dean of Kildare,	1849,	2	2	0			
William Grimshaw, M. D.,	„	2	2	0			
Arthur S. Ormsby, Esq.,	„	2	2	0			
Rev. Joseph A. Galbraith,	„	2	2	0			
Robert Tighe, Esq.,	1850,	2	2	0			
W. T. Kent, Esq.,	1849,	2	2	0			
William Andrews, Esq.,	„	2	2	0			
M. R. Sausse, Esq.,	„	2	2	0			
Acheson Lyle, Esq.,	1848,	2	2	0			
Ditto,	1849,	2	2	0			
Venerable Archdeacon Cotton,	1850,	2	2	0			
Charles Vignoles, Esq.,	„	2	2	0			
N. P. O'Gorman, Esq.,	„	2	2	0			
William Henn, Esq.,	„	2	2	0			
Michael Donovan, Esq.,	„	2	2	0			
Right Hon. Lord Chancellor,	„	2	2	0			
R. V. Boyle, Esq.,	„	2	2	0			
Samuel Ferguson, Esq.,	1849,	2	2	0			
P. D. Hardy, Esq.,	„	2	2	0			
James C. Kenny, Esq.,	1850,	2	2	0			
John Anster, LL. D.,	1849,	2	2	0			
R. J. Graves, M. D.,	1850,	2	2	0			
M. M. O'Grady, M. D.,	„	2	2	0			
Francis L'Estrange, Esq.,	„	2	2	0			
Rev. R. V. Dixon,	1848,	2	2	0			
Ditto,	1849,	2	2	0			
Rev. John Alcorn,	1850,	2	2	0			
Hon. James King,	„	2	2	0			
T. E. Beatty, M. D.,	1849,	2	2	0			
Chichester Bolton, Esq.,	1848,	2	2	0			
Ditto,	1849,	2	2	0			
Lord W. Fitzgerald,	1850,	2	2	0			
Henry Freke, M. D.,	„	2	2	0			
J. K. Ingram, Esq.,	1849,	2	2	0			
George Cash, Esq.,	„	2	2	0			
Rev Thomas Stack,	„	2	2	0			
J. L. Rickards, Esq.,	1850,	2	2	0			
T. J. Beasly, Esq.,	1849,	2	2	0			
William Brooke, Esq.,	1850,	2	2	0			
William Edington, Esq.,	„	2	2	0			
Forward,		321	6	0	1100	9	1

		£	s.	d.	£	s.	d.
Brought forward,		321	6	0	1100	9	1
Fleetwood Churchill, M. D.,	1850,	2	2	0			
Lord Farnham,	„	2	2	0			
William Hogan, Esq.,	„	2	2	0			
W. C. Dobbs, Esq.,	1849,	2	2	0			
Ditto,	1850,	2	2	0			
Richard Cane, Esq.,	„	2	2	0			
Edward Cane, Esq.,	„	2	2	0			
A. B. Cane, Esq.,	„	2	2	0			
Dean of St. Patrick's,	„	2	2	0			
John M'Mullen, Esq.,	„	2	2	0			
Charles Doyne, Esq.,	„	2	2	0			
D. F. Brady, M. D.,	„	2	2	0			
John Burrowes, Esq.,	„	2	2	0			
Hon. James Talbot,	„	2	2	0			
John Bell, Esq.,	„	2	2	0			
Hon. Thomas Vesey, M. P.,	„	2	2	0			
His Grace the Archbishop of Dublin,	„	2	2	0			
C. T. Webber, Esq.,	„	2	2	0			
Edward Hutton, M. D.,	„	2	2	0			
Total Annual Subscriptions,					361	4	0
SUBSCRIPTIONS FOR THE PURCHASE OF THE BETHAM MANUSRICPTS.							
Colonel Harry D. Jones, R. E.,		5	0	0			
Sir Wm. Rowan Hamilton, LL. D.,		3	0	0			
W. H. Harvey, M. D.,		1	0	0			
Rev Richard Mac Donnell, D. D.,		1	0	0			
Arthur B. Cane, Esq.,		1	0	0			
John Purser, Esq.,		2	2	0			
L. E. Foot, Esq.,		1	0	0			
M. M O'Grady, M. D.,		1	0	0			
Walter Sweetman, Esq.,		5	0	0			
G. J Allman, M. D.,		1	1	0			
Edmond Getty, Esq.,		1	0	0			
Aquilla Smith, M. D.,		1	0	0			
H. L. Renny, Esq.,		1	0	0			
John Finlay, LL. D.,		1	0	0			
Philip Jones, Esq.,		1	0	0			
Rev. J. K. Bailie, D. D.,		2	2	0			
Captain T. A. Larcom, R. E.,		5	0	0			
W. E. Hudson, Esq.,		10	0	0			
Hon. James Talbot,		1	0	0			
Charles Tarrant, Esq.,		5	0	0			
Forward,		49	5	0	1461	13	1

	£	s.	d.	£	s.	d.
Brought forward,	49	5	0	1461	13	1
W. C. Kyle, Esq., ...	1	0	0			
Algernon Preston, Esq., ...	1	1	0			
James Apjohn, M. D., ...	1	0	0			
William M'Dougall, Esq., ...	1	0	0			
J. S. Close, Esq., ...	2	0	0			
F. W. Conway, Esq., ...	5	0	0			
Wyndham Goold, Esq., ...	3	0	0			
W. O'Hara, Esq., ...	5	0	0			
Hon. Sidney Herbert, ...	10	0	0			
"H." per E. Clibborn, ...	5	0	0			
Jonathan Pim, Esq., ...	1	0	0			
Thomas Clarke, Esq., ...	1	0	0			
Rev. R. V. Dixon, ...	1	0	0			
Robert Ball, Esq. (2nd Subscription), .	5	0	0			
Total Subscription for purchase of Betham Manuscripts, ...				91	6	0
SUBSCRIPTION FOR EXCAVATION AT DOWTH TUMULUS.						
Charles Haliday, Esq., ...	. . . . .			1	0	0
TOTAL AMOUNT OF CHARGE, . .	. . . . .			1553	19	1

THE DISCHARGE.

ANTIQUITIES PURCHASED.				£	s.	d.	£	s.	d.
Blackall, Charles, five swords, ...				1	0	0			
Campion, J. C. M., bronze instrument, . .				0	2	0			
Curry, John, brass spurs, ...				1	0	0			
Devitt, James, sundries, ...				0	17	6			
Donegan, John, gold ornaments, ...				8	0	0			
Glennon, Richard, bronze pan, ...				0	2	6			
Hughes, Patrick, sundries, ...				0	12	6			
M'Allister, P., coins, ...				5	0	0			
Milliken, T., bronze sword, ...				2	0	0			
M'Connell, J., bronze celt, ...				0	1	0			
Morrow, Edward, round stone, ...				0	1	0			
Nalty, Michael, stone celts, ...				0	9	0			
Naughton, John, celts, ...				0	9	0			
O'Kelly, B., bronze pot, &c., ...				1	2	6			
Wilde, W. R., bell, ...				5	0	0			
Reid, John, stone hatchet, ...				0	17	6			
Underwood, James, sundries, ...				3	10	0			
Total Antiquities purchased, . .							30	4	6
BOOKS, PRINTING, AND STATIONERY.									
Camden Society, subscription to, ...				1	0	0			
Curry, Eugene, on account of transcribing Brehon Laws, .	£15	0	0						
Ditto, on account of transcribing Irish manuscript, ...	16	0	0						
Ditto, on account of transcribing the Tripartite Life of Saint Patrick, ...	15	0	0						
				46	0	0			
Du Noyer, George, Outlines of Ogham Stone,				3	0	0			
Ferrier, Pollock, and Co., paper, ...				1	1	8			
Gill, M. H., printing Proceedings,	£171	9	10						
Ditto, miscellaneous Printing, .	73	13	8						
				245	3	6			
Hanlon, G. A., on account of wood-cuts, .				41	0	0			
Forward,				337	5	2	30	4	6

	£	s.	d.	£	s.	d.
Brought forward,	337	5	2	30	4	6
Hodges and Smith, books,	44	6	6			
Hendrick, E., account books and paper,	3	4	0			
Jones, J. F., books,	9	2	0			
Johnston and Co., advertising,	3	0	6			
Knox, William, engravings,	8	18	3			
Murphy, J., books,	0	10	0			
Oldham, W., engravings,	4	3	0			
O'Shaughnessy, J., printing,	1	19	0			
Plunket, James, catalogue of antiquities,	7	18	0			
Perry, J. and H., paper,	2	8	6			
Press Newspaper, advertising,	0	3	6			
Ponsonby, E., paper,	4	3	0			
Ray Society, subscription to,	1	1	0			
Saunders's News-Letter, advertising,	0	13	0			
Sharpe, H., books,	0	12	0			
Taylor, R. and J. E., Memoirs,	2	14	0			
Tallon, John, Jun., sundries,	1	5	11			
Trainer, A. H., brushes,	0	5	0			
Walsh, N., envelopes,	0	4	0			
Wogan, David, advertising,	1	6	0			
Woodhouse, William, paper die,	0	15	0			
Total Amount of Books, Printing, and Stationery, &c.,				435	17	4

COALS, GAS, ETC.

	£	s.	d.	£	s.	d.
Alliance Gas Company for gas,	8	16	0			
Ditto, ditto, for coke,	3	15	8			
Goodbody, T. and P., for candles,	1	16	0			
Hoey, Christopher, coals,	10	17	0			
Lang and Co., coals,	4	16	0			
Spear and Co., wax taper,	0	0	6			
Tharel, P., wax tapers,	0	5	3			
Total Amount of Coals, &c.,				30	6	5

REPAIRS OF HOUSE.

	£	s.	d.	£	s.	d.
Brown, John, cleaning windows, &c., and painting, &c.,	10	19	6			
Moran, John, sweeping chimneys,	0	5	0			
Murphy, J., ditto,	0	15	6			
Surman, George, repairs,	7	9	6			
Total Repairs of House,				19	9	6
Forward,				515	17	9

	£	s.	d.	£	s.
Brought forward,	.	.	.	515	17
FURNITURE AND REPAIRS.					
Daniel, P., screws,	0	2	0		
Jones, J. F., glazed cases,	2	2	0		
Hoy, C., matting,	1	0	0		
Rounds, E., paper,	0	2	0		
Sharpe, Richard, winding clocks,	0	17	6		
Sibthorpe, H. and Son, glass,	0	2	6		
Surman. George, sundry furniture,	21	7	11		
White, William, jar,	0	2	8		
Total Furniture and Repairs,				25	16
RENT, TAXES, AND INSURANCE.					
National Insurance Company,	9	16	0		
Globe Insurance Company,	5	13	6		
Rent of house,	104	9	0		
Minister's Money,	2	15	5		
Pipe Water Tax,	1	19	2		
Total Rent, Taxes, and Insurance,				124	13
SALARIES, WAGES, ETC.					
Ball, Robert, LL. D., Treasurer,	21	0	0		
Clibborn, Edward, salary,	150	0	0		
Curry, Anthony,	2	15	0		
Ditto, arranging Museum,	7	0	0		
Drummond, Rev. W. H., D. D., Librarian,	21	0	0		
Graves, Rev. Charles, A. M., Secretary to Council,	21	0	0		
Hamilton, William, hall-porter,	34	4	8		
Ditto, Christmas allowance,	2	2	0		
Lockhart. J., suit of livery,	5	19	0		
O'Brien, Thomas, messenger,	39	0	0		
Plunkett, James, arranging Museum,	4	3	0		
Todd, Rev. J. H., D. D., Secretary to Academy,	21	0	0		
Todhunter, Isaac, Accountant,	46	0	0		
Total Salaries, Wages, &c.,				375	3
Forward,	.	.	.	1041	11

	£	s.	d.	£	s.	d.
Brought forward,	.	. .	. .	1041	11	1
CONTINGENCIES.						
Edward Clibborn, half-year's allowance for cleansing house, ...	5	0	0			
Ditto, for freight on books, postage, stamps, and sundry small charges, ...	25	4	0			
Total Contingencies, . . .				30	4	0
BETHAM MANUSCRIPTS.						
Sir William Betham, on account of his manuscripts, ...	324	0	0			
Total paid on account of Betham manuscripts, . . .				324	0	0
EXCAVATION AT DOWTH.						
Edward Clibborn, on account of excavation at Dowth, ...	19	12	0			
Total paid on account of excavation at Dowth, . .				19	12	0
Total Discharge, ...	. . . . .£			1415	7	1
Balance in favour of the Public, .	. . . .			138	12	0
Total Amount of Charge, . . .	. . . . .£			1553	19	1

STATE OF THE BALANCE.

	£	s.	d.
In Bank of Ireland, ...	74	8	11
In Treasurer's hands, as per account, . . .	64	3	1
	£138	12	0

The Treasurer reports that there is to the credit of the Academy in the Bank of Ireland, £717 1*s.* 10*d.* in Three per Cent. Consols, and £1643 19*s.* 6*d.* in Three and a quarter per Cent. Government Stock, the latter known as the Conyngham Fund.

(Signed), ROBERT BALL,
Treasurer.

30*th March*, 1850.

THE
ROYAL IRISH ACADEMY,

MARCH 16, 1850.

Patroness,

HER MOST SACRED MAJESTY,
THE QUEEN.

Visitor,

HIS EXCELLENCY THE LORD LIEUTENANT OF IRELAND.

President,

REV. HUMPHREY LLOYD, D.D.

Elected 16th March, 1846.

Vice-Presidents,

(Nominated by the President.)

1847—REV. C. W. WALL, D. D., VICE-PROVOST, T. C. D.
1848—HIS GRACE THE ARCHBISHOP OF DUBLIN.
1849—JOHN ANSTER, LL. D.
1850—JAMES APJOHN, M. D.

COUNCIL.

Committee of Science.

Elected.
1808—REV. FRANC SADLEIR, D. D., PROVOST, T. C. D.
1827—SIR WILLIAM R. HAMILTON, LL. D.
1833—JAMES APJOHN, M. D.
1838—ROBERT BALL, LL. D.
1840—SIR ROBERT KANE, M. D.
1844—GEORGE J. ALLMAN, M. D.
1847—REV. SAMUEL HAUGHTON, F. T. C. D.

Committee of Polite Literature.

Elected.
1821—Rev. William H. Drummond, D. D.
1838—Rev. C. W. Wall, D. D., Vice-Provost, T. C. D.
1842—John Anster, LL. D.
1844—Rev. Charles Graves, A. M., F. T. C. D.
1844—Rev. Samuel Butcher, D. D., F. T. C. D.
1847—His Grace the Archbishop of Dublin.
[Vacant.]

Committee of Antiquities.

1830—George Petrie, LL. D.
1837—Rev. James H. Todd, D. D., F. T. C. D.
1842—J. Huband Smith, A. M.
1842—Captain Larcom, R. E.
1846—Frederick W. Burton, Esq., R. H. A.
1847—Samuel Ferguson, Esq.
1849—Aquilla Smith, M. D.

Officers.

Treasurer—Robert Ball, LL. D.
Secretary of the Academy—Rev. James H. Todd, D. D.
Secretary of Council—Rev. Charles Graves, A. M.
Secretary of Foreign Correspondence—Rev. Samuel Butcher, D. D
Librarian—Rev. William H. Drummond, D. D.
Clerk and Assistant Librarian—Edward Clibborn.

Printed by Order of the Committee of Publication, Dec. 2, 1850.

HONORARY MEMBERS.

Elected.

1849 His Royal Highness, Prince Albert.

1838 Northampton, Spencer Joshua Alvyne, Marquis of. Ex-President and F. R. S. of London, &c. *London.*

1832 Rosse, Rt. Hon. William, Earl of, President of the Royal Society of London, F. R. A. S., &c. *Birr Castle, Parsonstown.*

Section of Science.

1832 Airy, George Biddell, M. A., F. R. S., &c., Astronomer Royal. *Greenwich.*

1844 Arago, François Jean Dominique. *Paris.*

1826 Babbage, Charles, M. A., F. R. S., &c. *London.*

1850 Bache, Alexander D. *Washington, D. C., United States.*

1822 Brewster, Sir David, K. H., LL. D., F. R. S., &c. *St. Andrews.*

1836 Brisbane, Lieut.-General Sir Thomas Mac Dougal, K. C. B., F. R. S., Pres. R. S. E. &c. *Kelso.*

1826 Brown, Robert, D. C. L., F. R. S., &c. *British Museum, London.*

1836 Daubeny, Charles Giles Bridle, M. D., F. R. S., &c. *Oxford.*

1841 Dumas, Jean Baptiste. *Paris.*

1820 Dupin, Charles. *Paris.*

1843 Gauss, Karl Friedrich. *Gottingen.*

1825 Greville, R. K., LL. D. *Edinburgh.*

Elected.	
1826	Herschel, Sir John Frederick William, Bart., D. C. L., F. R. S., &c. *Hawkhurst.*
1825	Hooker, Sir William Jackson, K. H., LL. D., F. R. S.
1849	Humboldt, Alexander Von. *Berlin.*
1832	Jameson, Robert, Esq., F. R. S., &c.
1835	König, Charles, Esq., K. H., F. R. S., &c. *London.*
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1836	Murchison, Sir Roderick Impey, Knt., F. R. S., &c. *London.*
1828	Parry, Sir William Edward, Knt., D. C. L., Captain R. N., F. R. S., &c. *London.*
1841	Quetelet, Adolphe Jacques. *Brussels.*
1836	Rennie, George, Esq., F. R. S., &c. *London.*
1823	Schumacher, Heinrich Christian. *Altona.*
1835	Sedgwick, Rev. Adam, M. A., F. R. S., &c. *Cambridge.*
1834	Somerville, Mrs. Mary. *Chelsea.*
1826	South, Sir James, Knt., F. R. S., &c. *Kensington.*
1836	Sykes, Lieut.-Col. William Henry, F. R. S., &c. *London.*
1836	Thomson, Thomas, M. D., F. R. S., &c. *Glasgow.*
1842	Wheatstone, Charles, Esq., F. R. S., &c. *London.*
1836	Whewell, Rev. William, D. D., F. R. S., &c. Master of Trinity College, Cambridge. *Cambridge.*

SECTION OF POLITE LITERATURE.

1850	Boeck, Augustus. *Berlin.*
1849	Bopp, Franz. *Berlin.*
1835	Combe, George, Esq. *Edinburgh.*
1850	Cousin, Victor. *Paris.*
1849	Grimm, Jacob. *Berlin.*
1849	Guizot, Françoise Pierre Guillaume. *Paris.*
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Elected.

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1850 Irving, Washington. *Sunnyside, Dobb's-Ferry, New York.*

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1849 Lepsius, Richard. *Berlin.*

1846 Moore, Thomas, Esq. *Sloperton Cottage, Devizes.*

1849 Ranke, Leopold. *Berlin.*

1850 Thiers, A. *Paris.*

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SECTION OF ANTIQUITIES.

1848 Botta, P. E. *Paris.*

1826 Brewer, James N., Esq.

1848 Bunsen, Chevalier C. C. J. *Carlton House Terrace, London.*

1833 Cooper, Charles Purton, LL. D., F. S. A., &c. *London.*

1835 Donop, Baron. *Saxe Meiningen.*

1832 Ellis, Rt. Hon. Sir Henry, K. H., Sec. S. A., &c. *London.*

1832 Forshall, Rev. Josiah, M. A., F. S. A., &c. *London.*

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1841 Halliwell, James Orchard, Esq., F. S. A., &c., *Brixton Hill, Surrey.*

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1850 Petit-Radel, L. C. F. *Paris.*

1827 Rafn, C. C. *Copenhagen.*

1837 Smyth, William Henry, Esq., Capt. R. N., D. C. L., F. S. A., &c. *Chelsea.*

1848 Thomsen, C. J. *Copenhagen.*

1805 Turner, Dawson, Esq., F. S. A., &c. *Yarmouth.*

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The Names of Life Members are marked with an Asterisk.

Elected.

1843 *Allman, George James, M. D., Professor of Botany, University of Dublin. 33, *Waterloo-road.*

1839 *Andrews, Thomas, M. D., F. R. S., *Vice-President, Queen's College, Belfast.*

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1833 *Armstrong, Andrew, Esq., A. M. 17, *College.*

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1843 Abeltshauser, Rev. I. George, A. M., Queen's Professor of French and German, University of Dublin. *St. Doulagh's.*

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1846 Aldridge, John, M. D. *Cecilia-street.*

1842 Andrews, William, Esq. 18, *Leinster-street.*

1850 Angeli, Signor Basilio, Queen's Professor of Italian and Spanish, University of Dublin. 17, *College.*

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1818 *Bailie, Rev. J. Kennedy, D. D. *Stewartstown.*

1822 *Bald, William, Esq., F. R. S. E. *Edinburgh.*

Elected.
1835 *Ball, Robert, LL. D., Director of the University Museum; Secretary of the Royal Zoological Society of Ireland; V. P. Geological Society of Dublin; Local Sec. Botanical Society of Edinburgh, and of the Ray Society, &c.—TREASURER. 3, *Granby Row.*
1840 *Ball, John, Esq. 85, *Stephen's-green.*
1842 *Banks, John T., M. D. 29, *Upper Merrion-street.*
1809 *Bateson, Sir Robert, Bart. *Belvoir Park, Belfast.*
1832 *Beaufort, Sir Francis, Admiral, F. R. S., F. G. S., F. R. A. S., &c. 11, *Gloucester-place, Portman-square, London.*
1825 *Benson, Charles, M. D. Professor of Physic, Royal College of Surgeons. 34, *York-street.*
1836 *Bergin, Thomas F., Esq. 49, *Westland-row.*
1827 *Betham, Sir William, Knt., Ulster King of Arms, F. S. A., F. R. A. S., V. P. Royal Dublin Society, *Stradbrook House, Blackrock.*
1850 *Bewglass, Rev. James, LL. D., *Taunton, Somerset.*
1843 *Blacker, Stewart, Esq. 20, *Gardiner's-place.*
1802 *Blood, Bindon, Esq. *Ennis.*
1836 *Bolton, William Edward, Esq. 3, *James's Terrace, Malahide.*
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1838 *Boyle, Alexander, Esq. *Killiney.*
1838 *Bruce, Halliday, Esq. 37, *Dame-street.*
1842 *Butcher, Rev. Samuel, D. D., Fellow of Trinity College.—SECRETARY OF FOREIGN CORRESPONDENCE. 13, *Fitzwilliam-square, West.*
1846 Baker, Abraham Whyte, Esq. *Ballaghtobin House, Callan.*
1847 Baker, A. Whyte, Jun., Esq. *Ballaghtobin House, Callan.*
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1845 Talbot, Hon. James. *Malahide Castle.*

1848 Talbot, Matthew E., Esq. *Ferry Bank, Wexford.*

1848 Taylor, Very Rev. J. J., D. D., President of Carlow College. *Castleknock.*

1841 Tighe, Robert, Esq. 14, *Fitzwilliam-square, North.*

1845 Townsend, R. William, Esq., C. E. *Derry, Roscarberry.*

1846 Tuffnell, Thomas Jolliffe, M. D. 58, *Lower Mount-st.*

1834 *Vandeleur, Crofton Moore, Colonel. *Kilrush.*

1849 Vesey, Hon. Thomas, M. P. *Abbeyleix.*

1836 Vignoles, Charles, Esq., F. R. S. *Trafalgar-square, London.*

1837 *Wall, Rev. Charles William, D. D., Vice-Provost of Trinity College.—VICE-PRESIDENT. 20, *College.*

Elected.
1823 *Wall, Rev. Richard H., D.D. 6, *Hume-street.*
1822 *Walshe, Francis Weldon, Esq. *Limerick.*
1816 *Weaver, Thomas, Esq., F.R.S., F.G.S. *London.*
1800 *Weld, Isaac, Esq., F. G. S., Vice-President Royal Dublin Society. *Ravenswell, Bray.*
1790 *Wilkinson, James Tandy, M.D., *Limerick.*
1837 *Williams, Thomas, Esq. *Drumcondra Castle.*
1839 *Williams, Richard Palmer, Esq. *Drumcondra Castle.*
1841 *Wilson, Thomas, Esq. *Westbury*, and 15, *Upper Temple-street.*
1844 *Wilson, Robert, Esq. 31, *Leeson-street.*
1833 Walker, Roger Chambers, Esq. 2, *Granby-row.*
1840 Wallace, Robert Alexander, Esq., A. M. 26, *Molesworth-street.*
1830 Wallace, William Baillie, Esq., A. M. 26, *Molesworth-street.*
1845 Waller, John Francis, Esq. 4, *Herbert-street.*
1838 Webber, Charles T., Esq. 22, *Upper Gloucester-street.*
1841 West, Rev. John, D.D. 28, *Herbert-place.*
1840 Wilkinson, George, Esq. *Custom-House.*
1846 Williams, Robert C., M. D. 58, *Upper Mount-street.*
1839 Wills, Rev. James. *Kilmacow, Waterford.*
1846 Wingfield, Hon. and Rev. William. *Abbeyleix.*
1843 Wynne, John, Esq. *Hazlewood, Co. Sligo.*

1845 Yeates, George, Esq. 2, *Grafton-street.*

Note.—The names of parties, whose subscriptions are in arrear for two years and upwards, are not printed in this list.